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Proposed

ARCTIC SAND AND GRAVEL LEASE SALE

Draft Environmental Impact Statement

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

I 1.98:

This EIS is not intended, nor should it be used, as a local planning document, by potentially affected communities. The facility locations and transportation scenarios described in this EIS represent best estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental impacts. Several years may elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent an MMS recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

UNITED STATES
DEPARTMENT OF THE INTERIOR

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

PROPOSED
OUTER CONTINENTAL SHELF
ARCTIC SAND AND GRAVEL LEASE SALE

Prepared by
Minerals Management Service

November 1982

DRAFT ENVIRONMENTAL IMPACT STATEMENT
Proposed Outer Continental Shelf
Arctic Sand and Gravel
Lease Sale

Summary Sheet

(X) Draft ( ) Final

U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, P.O. Box 1159, Anchorage, Alaska 99510.

1. Type of Action: Proposed Arctic Sand and Gravel Lease Sale.

(X) Administrative ( ) Legislative

2. Description of the Action: The leasing proposal consists of a total of 1,241,888 hectares (3 million acres) on the Outer Continental Shelf (OCS). The 616 blocks are located in the Beaufort Sea 5 to 60 kilometers (3 to 37 mi) offshore in waters that are from 5 to 40 meters (16 to 131 ft) deep. If implemented, this sale is tentatively scheduled to be held in May 1983.

3. Alternatives to the Proposed Action:

a. No Sale (Alternative II).

b. Delay the Sale (Alternative III).

c. Modify the proposed sale area by deleting 13 blocks in the Boulder Patch area (Alternative IV).

d. Modify the proposed sale area by deleting 18 blocks in the Weller Bank area and 12 blocks in the Stamukhi Shoal area (Alternative V).

4. Scoping comments were requested from the following:

Federal Agencies
- Department of Agriculture
  - Forest Service
- Department of Commerce
  - National Oceanic and Atmospheric Administration
  - National Marine Fisheries Service
  - Office of Coastal Zone Management, Washington, D.C.
  - OCSEAP Information Coordinator
  - National Weather Service
- Department of Defense
  - Army Corps of Engineers
- Department of Energy
  - Deputy Regional Representative
- Department of the Interior
  - Alaska Power Administration
  - Alaska Resources Library
  - Bureau of Indian Affairs

- Bureau of Land Management
  - Bureau of Mines
  - Federal Co-Chairman, Alaska Land Use Council
  - Fish and Wildlife Service
  - Geological Survey
  - National Park Service
- Department of Transportation
  - Coast Guard
- Environmental Protection Agency
- National Transportation Safety Board
- Postal Service

State of Alaska

- Congressman Don Young
- Department of Administration
- Department of Commerce and Economic Development
- Department of Community and Regional Affairs
- Department of Environmental Conservation
- Department of Fish and Game
- Department of Health and Social Services
- Department of Labor
- Department of Law
- Department of Natural Resources
  - Commissioner
  - Office of Research and Development-CZM Coordination
- Department of Revenue
- Department of Transportation and Public Facilities
- Office of the Governor
  - Division of Policy Development and Planning
  - Office of Coastal Management
- Senator Frank Murkowski
- Senator Ted Stevens
- University of Alaska
  - Arctic Environmental Information and Data Center
  - Arctic Project Office
  - Director of Native Studies
  - Institute of Marine Science
  - Institute of Social and Economic Research
  - Institute of Water Resources
  - Marine Advisory Program
  - Sea Grant Program

Local Government and Native Organizations

- Alaska Eskimo Whaling Commission
- Alaska Federation of Natives
- Alaska Legal Services Corporation
- Alaska Native Foundation
- Arctic Slope Corporation
- Arctic Slope Native Association
- Arctic Slope Regional Corporation
- Atkasook Corporation

Barrow City Manager
Bering Straits Native Corporation
Bristol Bay Native Association
Bristol Bay Native Corporation
Cully Corporation
Doyon Limited
Fairbanks Chamber of Commerce
Inupiat Community of the Arctic Slope
Kaktovik Inupiat Corporation
Kawerak, Incorporated
Kodiak Island Borough
Koniag, Incorporated
Kuukpik Corporation
Manilaq Association
Mayor, North Slope Borough, Eugene Brower
Mayor of Kaktovik, Archie K. Brower
Mayor of Nuiqsut, Thomas Napagiak
Mayor of Point Hope
Mayor Wainwright, Jacob Kagak
Municipality of Anchorage
Nome Chamber of Commerce, OCS Advisory Committee
North Pacific Rim
North Slope Borough
Northwest Alaska Native Association
Norton Sound Health Corporation
Nunamuit Corporation
Olgoonik Corporation
Sealaska Corporation
Tigara Corporation
Unalakleet Native Corporation
Ukpeagvik Inupiat Corporation

Oil Industry
A Ruddy Petina Oil Company
ABSORB
Alaska Construction and Oil
Alaska Constructors, Incorporated
Alaska Exploration Corporation
Alaska Interstate Company
Alaska Map Service
Alaska Oil and Gas Association
Amerada Hess Corporation
American Petroleum Institute
Amoco Production Company
Arco Alaska, Incorporated
Arco Oil and Gas
Arco Oilfield Services, Incorporated
Atlantic Richfield Company
BP Alaska Exploration, Incorporated
Brown and Root, Incorporated
Canadian Superior Oil Limited
CANSO Oil and Gas, Incorporated
Chevron USA Incorporated
Cities Service Oil Company

Cook Inlet Response Organization
Dome Petroleum Limited
Dillingham Maritime
Drilling Services Incorporated
Esso Resources Canada, Limited
Exxon Company, USA
F.M. Lindsey and Associates
Fluor Drilling Service, Incorporated
Geophysical Corporation of Alaska
Getty Oil Company
Gulf of Alaska Cleanup Organization
Gulf Oil Exploration and Production Company
Idemitsu Alaska Oil Development Corporation
Imco Services
LGL Limited
Marathon Oil Company
Mid-Continental Oil and Gas Association
Mitsubishi International Corporation
Mobil Oil Corporation
Morrison-Knudsen Company, Incorporated
Ocean Technology Limited
Ogle Petroleum Incorporated
Oil Patch Alaska, Incorporated
Pacific Lighting Gas Development
Page Else Limited
Parker Drilling Company
Petroleum Engineer International
Phillips Petroleum Company
Placid Oil Company
Resource Development Council
Shell Oil Company
Sohio Alaska Petroleum Company
Surety of Alaska, Inc.
Tams Engineers
Teleco Oil Field Services, Incorporated
Tenneco Oil
Tesoro Petroleum Corporation
Tetra Tech, Incorporated
Texaco Incorporated
Union Oil Company of California
Western Geophysical

Special Interest Groups
Alaska Public Interest Research Group
Audubon Society
Acoustical Society of America
Alaska Center for the Environment
Alaska Conservation Society
Bering Sea Fishermen's Association
Bristol Bay Regional Resources Center
Fairbanks Environmental Center
Friends of the Earth
Greenpeace Alaska
Isaac Walton League of America

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National Wildlife Federation
Pacific Seabird Group
Rural-CAP, Incorporated
Sea Use Program
Sierra Club
Trustees for Alaska
United Fishermen's Marketing Association
United Fishermen of Alaska

Other Organizations
Alaska Biological Research
Alaska Consultants
Alaska Industries Incorporated
Anchorage Community College
Dames and Moore
First National Bank
Historic Resource Consultants
Hughes Thorsness Gantz Powell and Brundin
Kevin Waring Associates
Lockheed Missiles and Space Company, Incorporated
Montana State University, College of Engineering
Sheldon Jackson College
Tryck, Nyman & Hayes
University of Washington, Institute for Marine Studies
West High School Science Department
Woodward-Clyde Consultants

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5. Technical Papers: This document makes extensive use of a series of technical papers prepared by the Minerals Management Service, Alaska OCS Region (see Bibliography). The material contained in these papers is incorporated by reference throughout this EIS. Copies of these papers have been placed in a number of libraries throughout Alaska. Single copies of these technical papers are available from the Minerals Management Service, Alaska OCS Region.

6. Contacts:

For further information regarding this draft environmental impact statement, contact:

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8. Public Hearings

Public hearings are tentatively scheduled to be held in mid-December 1982.

9. Comment Period on the Draft Environmental Impact Statement

Comments concerning the draft environmental impact statement should be received by January 7, 1983, and should be sent to the Minerals Manager, Minerals Management Service, Alaska OCS Region, P.O. Box 1159, Anchorage, AK 99510, Attn: Jim Seidl.

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C. Federal Regulatory Responsibilities

Summary of Environmental Impact Statement for Proposed Arctic Sand and Gravel Lease Sale

This environmental impact statement (EIS) discusses a proposal for sand and gravel leasing in the Beaufort Sea, alternatives to the proposal, major issues determined through the scoping process as well as staff analyses, and potential mitigating measures. The proposal consists of a total of 1,241,888 hectares (3 million acres) of OCS lands. The 616 blocks are located in the Beaufort Sea 5 to 60 kilometers (3 to 37 mi) offshore in waters that are from 5 to 40 meters (16 to 131 ft) deep. If implemented, this sale is tentatively scheduled to be held in May 1982.

The probable impacts addressed describe the mining and removal of the sand and gravel, per se, and its possible use in the construction of artificial islands for the conduct of oil and gas operations. These islands will be used to support exploration for and development of oil and gas resources throughout areas leased in the Joint Federal/State Beaufort Sea Sale (BF) and the Diapir Field Sale 71 (71). Additional assumptions that have been made to predict potential impacts are: (1) sand and gravel needs are about 190 million cubic meters of fill material, (2) there is sufficient fill material in the proposed sale area to satisfy these needs, (3) dredges will be used for mining, and (4) barges, pipelines, and hopper dredges will provide the means of transporting fill to the deposition site. See Section IV.A. for further detail.

The following discussion of potential impacts assumes that all laws, regulations, and orders are part of the proposal. If the proposed mitigating measures described in Section II.B.1.c. were adopted, it is expected that some impacts described in this EIS would be reduced. The potential effectiveness of the mitigating measures is described in each impact section (Sec. IV of the EIS). Impact analysis does not assume that lease terms and conditions or operating orders for this sale are in place.

Probable Impacts as a Result of the Proposal

Population-induced impacts assessed to the proposal are expected to be minor and short-term. Offshore mining operations are self-contained and personnel changes may or may not be made. If made, the only contact on the North Slope would be in the Prudhoe Bay airport. Islands and other facility construction using OCS-mined material may continue as long as hydrocarbons are produced from the area. However, because of the 2- to 2½-month open-water period yearly dredging operations would be short-lived.

Social systems impacts most likely to occur with gravel leasing on the OCS depend on the type of contacts or disturbance most likely to occur with dredging operations, crews, and subsistence species utilized locally. There would be minor effects on North Slope Borough political systems in the form of changing attitudes, increased coordination time and staffing, and increased air and marine transport contact through Prudhoe Bay-Deadhorse.

Potential disturbance of the subsistence whaling, sealing, fishing, and birding which is carried out near the barrier islands of Flaxman, Cross, Pingok, Tiguigiaq, Pole, and Foggy could have region-wide significance. However, onshore subsistence activities should not be affected by dredging and deposition of dredged material. Short-term impacts could result from reduced

reduced bird populations or relocated populations which may be less accessible. Bowhead whaling operations may also be hindered if the bowheads move too far offshore in efforts to avoid noise associated with dredging and deposition, and conflict could arise if barge traffic moving dredged material from a mining site to a deposition site interferes with whalers' maneuvering.

Mining activities on the OCS will involve the use of dredges and some sort of depositional method. The primary impact of these activities is that they make the water muddy (a decrease in water quality) but because the Beaufort Sea bottom sediments are uncontaminated, this decrease would be meaningless. However, the expression of impact is in the effect the water quality change has on the biological populations in the affected area.

The effects of dredging and deposition activities on the biological resources of the proposed sale area tend to be localized and temporal as discussed below. In each case, long-term effects are expected to be minimal and long-term regional effects are very unlikely.

Effects to benthic invertebrates may be the longest; these communities may require several years (possibly 5) to recover. Fish mortality through entrainment would probably be minor since fish density in the lease area is low and offshore from the migration routes of anadromous fish.

Noise may create a greater problem, although that, too, would be of short duration. Marine and coastal bird populations and marine mammals would likely avoid specific sites where mining operations are taking place due to the noise and the disruption of their food sources. However, significant, long-term regional impacts to marine and coastal birds and marine mammals as a result of the proposal are very unlikely.

Continuous noise, such as that associated with dredging, would not necessarily be disruptive to bowhead whales depending upong the site characteristics where the activity is occurring. Sporadic noise associated with barge movements, supply boats, or aircraft could be more disruptive. These types of noise may create an avoidance pattern, and a few bowhead whales are likely to be affected during the fall migration period. However, impacts on the overall population are most likely to be minor and short-term in duration; these short-term effects are not expected to preclude a successful migration. Long-term effects are expected to be minimal and long-term regional effects are very unlikely.

Gray whales are unlikely to be adversely affected by activities associated with the proposal. Although they might possibly react to certain types of acute and localized disturbances associated with dredging activities (i.e., increased vessel traffic and increased low-frequency noises), the existing information base strongly suggests that the types and levels of noise and disturbance will not significantly affect this population.

Probable Impacts of Alternatives II Through V

For sale alternatives II and III, no sale and delay of sale, respectively, there is a range of possible impacts. Without the sale, the oil and gas industry will either depend upon other sources of or methods to obtain available fill material or not construct all of the scheduled islands which may prohibit development of some tracts. With either alternative mining and deposition of offshore fill material will happen but only on the portions of the area leased for oil and gas. The postponement or delay of the sale may result in a delay of the proposed development schedules. The environmental impacts for both Alternatives II and III will be the same as those stated for the proposal. Alternative IV, deletion of 13 blocks of the Boulder Patch area, would eliminate impacts assessed for the proposal on benthic invertebrates and, fish. Alternative V, deletion of about 30 blocks in two offshore shoal areas, may reduce the minor impacts assessed to the proposal of changing circulation patterns and subsequently changing ice-grounding areas.

I.

PURPOSE OF THE ACTION

I. PURPOSE OF THE ACTION

The purpose for the proposed arctic sand and gravel lease sale in the Beaufort Sea is to offer for lease outer continental shelf (OCS) minerals (sand and gravel) primarily for the support of construction activities of the holders of oil and gas leases from the Joint Federal/State Beaufort Sea Sale (BF) and the Diapir Field Sale 71 (71). (See Fig. I-1 for a depiction of the sale area.) Section II contains a discussion of the activities that will result from this proposal and upon which the environmental effects of the proposal are analyzed.

The Need For the Action: Under the OCS Lands Act (OCSLA) of 1953 (67 Stat. 462; 43 U.S.C. 1331-1343), as amended (92 Stat. 629), the Department of the Interior is charged with administering the mineral development of the OCS. Pursuant to Section 8(k), the Secretary is authorized to lease any minerals, other than oil, gas, and sulphur, on the OCS on the basis of competitive bidding, and under such terms and conditions as he may prescribe at the time of offering the area for lease. Additionally, under the provisions of the Mining and Minerals Policy Act of 1970 (30 U.S.C. 21a), the Secretary is charged with the broad responsibility of fostering and encouraging private enterprise in mining and minerals activities. Under the Act, the Secretary of the Interior was given responsibility for implementing and carrying forth the national mining and minerals policy described therein and for reporting to the Congress on the state of the domestic mining, minerals, and minerals reclamation industries. Included within this authority and that of the OCSLA is the Secretary's responsibility for the design, implementation, and management of OCS minerals policy and development. The term "minerals," as defined in the OCSLA, includes not only oil and gas, but sulphur, geopressured-geothermal and associated resources, and all other minerals which are authorized by an act of Congress to be produced from "public lands" as defined in Section 103 of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1702).

The jurisdictional authority extended to the Department includes all submerged lands lying seaward and outside the areas beneath navigable waters as defined in Section 2 of the Submerged Lands Act of 1953 (67 Stat. 29; 43 U.S.C. 1301-1315), and of which the subsoil and seabed appertain to the United States. The Secretary not only has full authority to implement the leasing provisions of the OCS Act regarding minerals, but may also regulate how they will be extracted and produced.

Sand and gravel, a resource of high interest to industry in Alaska, will be needed primarily to support the construction of offshore gravel islands in the BF and 71 areas. Gravel islands are fundamental for exploration and development of oil and gas resources. To date "gravel island technology" is an accepted and proven approach to oil and gas development in arctic areas and is expected to remain so in the future. As oil and gas exploration moves into deeper waters dredged material from the OCS may be the most economical and feasible source for fill material in artificial island construction. Gravel island development in the Beaufort Sea is likely to require about 190 million cubic yards of material over the next 25 years (see Table II-1). Another aspect increasing the economic feasibility of developing sand and gravel on the OCS is the escalating cost of onshore mining and transportation of the material to the user site.

A. Leasing Procedures

The OCSLA as amended, charges the Secretary of the Interior with administering mineral exploration and development on the outer continental shelf as well as conserving its natural resources. The law, inter alia, requires that the Secretary of the Interior develop these minerals in an orderly and timely manner to meet the energy needs of the country; to protect the human, marine, and coastal environment; and to receive a fair and equitable return on the resources of the OCS.

Sand and gravel lease sales are planned and expected to be held on a periodic case-by-case basis to grant extraction rights, facilitate economic development of oil and gas in the arctic, and allow the Department of Interior time for planning sand and gravel lease sales following future OCS oil and gas lease sales. Periodic case-by-case lease sales would be based on need, resource availability, interest exhibited by industry, and a market. As oil and gas leasing proceeds in other areas of the arctic, OCS sand and gravel lease sales may correspond with OCS oil and gas lease sales.

The issuance of a sand and gravel lease or any other authorization under the OCSLA does not represent an exclusive use right to that tract. The conduct of leasing and management of sand and gravel exploration and development activities is implemented primarily by the Minerals Management Service (MMS) with assistance from other agencies as appropriate. MMS was established under Secretarial Order No. 3071 on January 19, 1982. Amendment No. 1 to the Order, dated May 10, 1982, transferred the authority of exercising all functions in direct support of the OCS program, including those previously performed by the Bureau of Land Management, to MMS.

The sand and gravel leasing decision process will parallel that of the oil and gas leasing process. The following is a brief discussion of the decision-making steps:

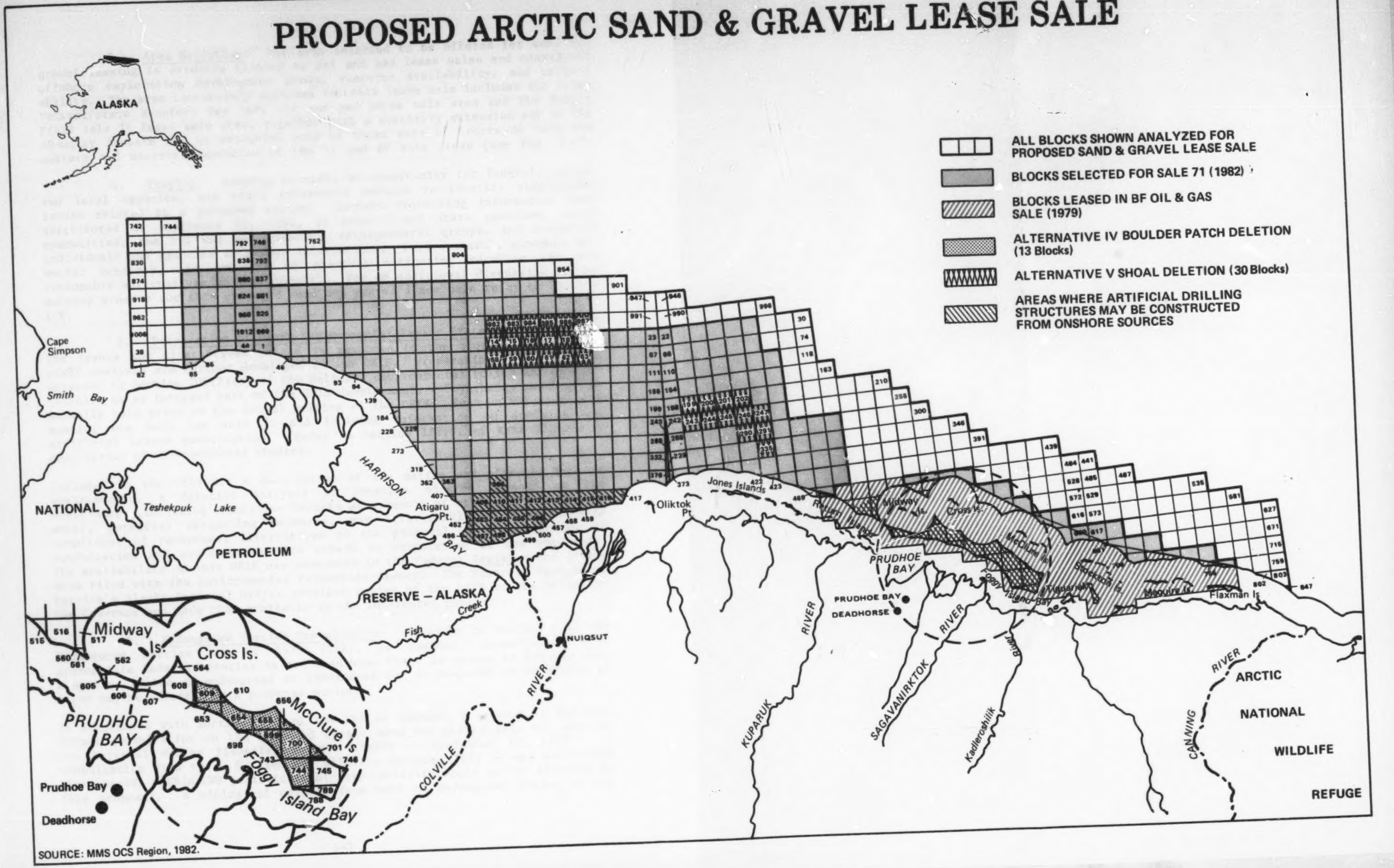
1. Request for Information: On January 5, 1981, a Request for Comments soliciting information on industry's interest in OCS hard minerals was published in the Federal Register (46 FR 1037). A total of seven companies, 15 states, two local planning boards, two federal agencies, and two private citizens responded.

On September 15, 1981, a site- and commodity-specific request for additional information was published in the Federal Register (46 FR 45820). This request specifically solicited data on sand and gravel in the arctic and on manganese off the South Atlantic States. Four companies and the State of Alaska responded.

2. Request for Resource Reports: Resource reports for the proposal were requested in March and April 1982 from the U.S. Geological Survey and the Minerals Management Service (prior to consolidation with the BLM OCS Office). These reports were received in May 1982. They provided information on the geologic framework of sand and gravel distribution in both areas and information on biological and environmental considerations. This information is important in determining the suitability for leasing and the need for possible mitigating measures for certain portions within the lease area.

Figure I—1

PROPOSED ARCTIC SAND & GRAVEL LEASE SALE


ALASKA
▭ ALL BLOCKS SHOWN ANALYZED FOR PROPOSED SAND & GRAVEL LEASE SALE
▦ BLOCKS SELECTED FOR SALE 71 (1982)
▨ BLOCKS LEASED IN BF OIL & GAS SALE (1979)
▩ ALTERNATIVE IV BOULDER PATCH DELETION (13 Blocks)
▧ ALTERNATIVE V SHOAL DELETION (30 Blocks)
▨ AREAS WHERE ARTIFICIAL DRILLING STRUCTURES MAY BE CONSTRUCTED FROM ONSHORE SOURCES
Cape Simpson
Smith Bay
NATIONAL
Teshekpuk Lake
PETROLEUM
RESERVE – ALASKA
HARRISON BAY
Atigaru Pt.
Fish Creek
NUIQSUT
COLVILLE RIVER
Oliktok Pt.
Jones Islands
KUPARUK RIVER
PRUDHOE BAY
DEADHORSE
SAGAVANIRKTOK RIVER
Kadleroshilik River
Midway
Cross Is.
McClure Is.
Foggy Island Bay
Maguire Is.
Flaxman Is.
CANNING RIVER
ARCTIC
NATIONAL
WILDLIFE
REFUGE
Midway Is.
Cross Is.
PRUDHOE BAY
McClure Is.
Foggy Island Bay
Prudhoe Bay
Deadhorse

SOURCE: MMS OCS Region, 1982.

3. Area Selection: The area selected to be offered for sand and gravel leasing is directly related to oil and gas lease sales and considered offshore exploration development needs, resource availability, and marketability. The area tentatively selected for this lease sale includes the Joint Federal/State Beaufort Sea (BF) oil and gas lease sale area and the Diapir Field sale 71 lease sale area, together with a northerly extension out to the 30-meter isobath and an extension zone of three sets of tracts on both the eastern and western boundaries of the 71 and BF sale areas (see Fig. I-1).

4. Scoping: Scoping provides an opportunity for federal, state, and local agencies, and other interested persons to identify significant issues related to a proposed action. Letters requesting information were distributed on September 15, 1982, to federal and state agencies, local communities, the oil and gas industry, environmental groups, and concerned individuals and agencies to gather information on environmental, economic and social concerns, and comments on possible mitigating measures and any reasonable alternatives to the proposal. For an additional discussion of the scoping process for this proposed sand and gravel lease sale refer to Section I.E.

5. Preparation of Draft Environmental Impact Statement (DEIS): The issues and alternatives raised in response to the scoping letters and staff analysis are further developed in the DEIS. Preparation of the DEIS is pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA). As an integral part of the DEIS development, a "synthesis meeting" is normally held prior to the actual writing of the DEIS. Such an MMS-sponsored meeting was held for sale 71 and included information on dredging and artificial island construction. Refer to Section III.F. of this EIS for a description of MMS-sponsored studies.

Included in the DEIS are a description of the marine and affected onshore environments, a detailed analysis of possible adverse impacts on the environment (including cumulative impacts as a result of other projects in the area), potential mitigating measures, any irreversible or irretrievable commitment of resources, alternatives to the proposal, and the records of consultation and coordination with others in preparation of the statement. The availability of this DEIS was announced in the Federal Register and copies were filed with the Environmental Protection Agency. The Minerals Management Service's Alaska Regional Office provided copies of the DEIS to the Office of the Governor and made them available to the interested public.

6. Endangered Species Consultation: Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, consultation with appropriate federal agencies is required when there is reason to believe that a species listed as endangered or threatened (or is proposed to be listed as such) may be affected by a proposed action.

In accordance with Section 7(c) of the ESA as amended, a request to initiate formal consultation on the proposed arctic sand and gravel sale was sent to the National Marine Fisheries Service (NMFS) on September 30, 1982. In consultation with the U.S. Fish and Wildlife Service (FWS) it was determined that species within FWS jurisdictional responsibility would not be affected by this proposal. A biological opinion from NMFS on Endangered Whales of the

Arctic Region with respect to sand and gravel leasing is expected in December 1982.

7. Public Hearings: Public hearings are held after release of the DEIS, and specific dates and locations for public hearings are announced in the Federal Register. Oral and written comments are obtained and incorporated into a Final Environmental Impact Statement (FEIS), which is then made available to the public. A public hearing will be held in Anchorage in mid-December 1982. Comments of interested parties on the North Slope will be heard through a teleconference system. The period for receipt of public comments on the DEIS for consideration of this proposal ends January 7, 1983. The FEIS is tentatively scheduled to be available to the public in April 1983.

8. Decision and Notice of Sale: After all of the above steps have been taken, the Secretary makes his final decision on whether to hold the sale and, if so, the terms and conditions to be included in the Notice of Sale. The notice will be published in the Federal Register at least 30 days before the sale.

9. Lease Sale: Sealed industry bids for individual tracts are opened and read at the lease sale. The Secretary reserves the right to withdraw tracts from the proposed sale, as well as reject any bids received. The Secretary has 90 days to accept or reject all bids. The proposed arctic sand and gravel lease sale is tentatively scheduled for May 1983.

B. Leasing History

There has not been an OCS sand and gravel lease sale conducted as authorized by the OCSLA as amended. During January 1981, the Secretary of the Interior announced his intention to open the OCS to leasing minerals other than oil and gas. The Secretary's decision to proceed with the non-energy minerals leasing program was directed toward a case-by-case approach based on industry interest. The initial expression of industry interest was the need for sand and gravel in the Beaufort Sea area to support exploration and possible development of oil and gas leases. To this end proposed sale activities were started. This DEIS is one phase of those activities.

C. Legal Mandates and Authorities

The description of legal mandates and authority for OCS leasing is contained in Appendix B. The description contains a summary of the OCS Lands Act, as amended, and the provisions of the Act for Federal/State coordination, the establishment of compensatory funds, and the environmental studies program.

D. Federal Regulatory Responsibilities

Federal regulatory responsibilities that affect sand and gravel leasing are contained in Appendix C. Responsibilities of components of the Departments of Interior, Transportation, and Commerce are described as well as those for the U.S. Army Corps of Engineers, and the Environmental Protection Agency. The criteria for ocean discharge has been promulgated by the Environmental Protection Agency, published October 3, 1980, 45 Federal Register 65942.

E. Scoping Process

There were no scoping meetings held specifically regarding this proposal. An information document was sent out September 15, 1982, requesting written comments by October 1, 1982. Eight written responses were received from the following: the Natural Resources Defence Council, Inc., the State of Alaska Department of Fish and Game, the North Slope Borough, Gulf Oil Exploration and Production Company, Marathon Oil Company, Exxon Company, U.S.A., Sohio Alaska Petroleum Company, and the Alaska Oil and Gas Association.

This is the third federal activity of a similar nature since the Call for Nominations for the BF sale area in March 1978. Primary issues of concern have not changed during the period from 1978 until now. In addition to the public hearings and written comments on the BF DEIS, scoping meetings and public hearings were held and written comments were received on the 71 DEIS. In all cases environmental concerns centered around: endangered species and marine mammals; subsistence; Inupiat culture; North Slope Borough Coastal Management Plan and other zoning ordinances; cumulative impact assessment; oilspills; and ice hazards. Industry interests were primarily in support of the sales. See Section V.D. for more information.

II.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. Borrow Resource Estimates and Production Assumptions

Borehole and high-resolution seismic data on sand and gravel in the Beaufort Sea area are sparse, making any attempt to extrapolate from incomplete knowledge, highly speculative. In addition, the information which has been collected on the Beaufort Sea continental shelf area shows even surficial properties of sediment character to be extremely patchy and variable, severely limiting attempts at estimating total sand and gravel resources in such a vast region. Perhaps the most important observation to be made, after carefully examining the data collected on the Beaufort Shelf, is that an attempt to carefully document sand and gravel resources is difficult.

What is known about sand and gravel resources is generally shown in Figure II-1. Although several paleovalleys are believed to be present in the proposed sale area, only the Sagavanirktok Paleovalley has been well delineated by offshore drilling. The Sagavanirktok Paleovalley begins in Prudhoe Bay and turns northwestward to pass between the West Dock and Reindeer Island; it has been traced farther northwestward to a point about 10 kilometers north of the mouth of the Kuparuk River. Gravel in the Sagavanirktok Paleovalley is unfrozen and lies beneath soft, unconsolidated marine clay, silt, and fine sand up to 10 kilometers thick. This paleovalley is a dependable source of coarse, gravelly fill; however, much of it is in state waters.

Geological reasoning suggests that a paleovalley should also be present off the mouth of the Colville River in eastern Harrison Bay, but the geophysical techniques employed thus far are not capable of delineating a buried valley filled with gravel, and drilling has been inadequate to verify its presence. Test drilling suggests that a line from Oliktok Point to Thetis Island crosses a submerged and buried geologic boundary between silt and clay to the west and unfrozen gravel to the east. This boundary very likely marks the western margin of the Colville Paleovalley.

In Harrison Bay and elsewhere in or near the proposed sale area, there are several potential sites for sand and gravel mining on the surface of the seabed. Most of these bodies are present because hydraulic forces are focused at these locations. Many of these shallow water features are within state waters and are not a part of this proposed sale.

Pacific Shoal (Fig. II-1) is a broad body consisting mainly of sand standing no more than 1.5 meters above the surrounding bottom (Barnes et al., 1980). Finger Shoal is a field of linear, parallel sand waves oriented north-south that are 1.5 meters high and 200 meters wide, sitting on a surface of stiff, silty clay. A shoal similar to Pacific Shoal lies to the south (Reimnitz and Minkler, 1981). These areas each contain about 100,000 cubic meters of sand.

Active sand ridges, 1 or 2 meters thick and 100 meters or more wide, lie within the 10-meter isobath in a belt extending from Pingok Island westward past Spy and Thetis Islands. Studies by Barnes and Reimnitz (1979) and Reimnitz et al. (1980) indicate that these are active hydraulic bedforms. Off Pingok Island, these sand bodies are longshore and transverse bars that are products of littoral processes.

The outer fringes of the 2-meter bench off the Colville River Delta consist of fine sand interbedded with mud layers rich in organic matter (Barnes et al., 1979). If suitable for construction material, about 1.5 million cubic meters of muddy sand could be removed here.

On the outer part of the proposed sale area, Stamukhi Shoal, 20 kilometers north of Pingok Island (Reimnitz and Maurer, 1978; Barnes et al., 1980), and Weller Bank, more than 40 kilometers north of the Colville River Delta (Barnes and Reiss, 1981), are bodies of sand and gravel of unknown origin that project 5 to 10 meters above the surrounding sea floor. Stamukhi Shoal is adjoined on the west by a sand apron that curves southwestward and consists of hydraulic bedforms up to 2 meters thick (Reimnitz and Kempema, 1981).

Weller Bank, the largest and most equidimensional body of sand and gravel, forms a boundary between fast ice and moving ice, controlling the position of the stamukhi zone as does Stamukhi Shoal.

It is estimated that a lease block size area (5.8 km on a side) mined to a depth of 1 meter would yield about 27 million cubic meters of fill material. This shoal area covers 18 lease blocks and could contain in the top meter enough fill material to build all the islands estimated to be necessary to develop the BF and 71 oil and gas sale areas (190 million cubic meters).

This EIS is not intended, nor should it be used, as a local planning document, by potentially affected communities. The facility locations and transportation scenarios described in this EIS represent best estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental impacts. Several years may elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent an MMS recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable state and local laws and regulations.

B. Analysis of Proposal and Alternatives

1. Alternative I (Proposal):

a. **Description of the Proposal:** The 616 blocks contained in this proposed action (Fig. I-1) are scheduled for sale in May of 1983. Total aerial extent of the proposed lease sale is 1,241,888 hectares (3 million acres). The blocks which comprise the proposed action are located about 5 to 60 kilometers (3-37 mi) offshore in water depths which range from 5 to 40 meters (16-131 ft). A summary of these blocks by water depth and distance to shore is found in Appendix A of this document.

Basic Development Assumptions: Current state-of-the-art technology for oil and gas exploration in the arctic includes the use of artificial islands as drilling platforms. The islands are built of fill materials mined on or offshore. The scenario for the sand and gravel lease sale concerns itself with the sale, extraction, and expected use of providing offshore sand and gravel in support of the building of these islands--from the dredging of the sea bed to depositing the fill to topping off the island. The islands may be for exploration or production, but the scenario ends for this proposal once a sale has been held, the sand and gravel extracted, and the island constructed. Also analyzed in this EIS are other possible uses of sand and gravel, such as in the building of causeways. The quantity of sand and gravel in the proposed lease sale area is presently unknown.

Estimated Activity Resulting from the Proposal: The amount of activity that may be generated from this proposed sale is expected to be a function of the activity resulting from oil and gas lease sales 71 and BF. Island construction is only one phase in the total spectrum of oil and gas operations and the number of islands built will correspond to the development scenarios for those oil and gas lease sales. Development and exploration are not mutually exclusive. Table II-1 shows the estimated schedule of artificial island construction, including dredge requirements, construction-time per island, and total fill dredged for an average island. (Tables II-2 and II-3 provide data on a variety of artificial island types for exploration and production islands, respectively.)

Should hydrocarbons be located during the exploratory period which could start in 1983, it is hypothesized that the developmental period could begin as early as 1984 with the building of one production island.

Peak island building activity for exploration could occur in 1987 and 1988 with three islands being built each year. Peak production island construction could occur in 1991 and 1992 with four islands being built each year. The developmental period could end by 1993 after construction of 12 production islands.

Further definition of the basic assumptions used for this sale will be found in Section IV.A.

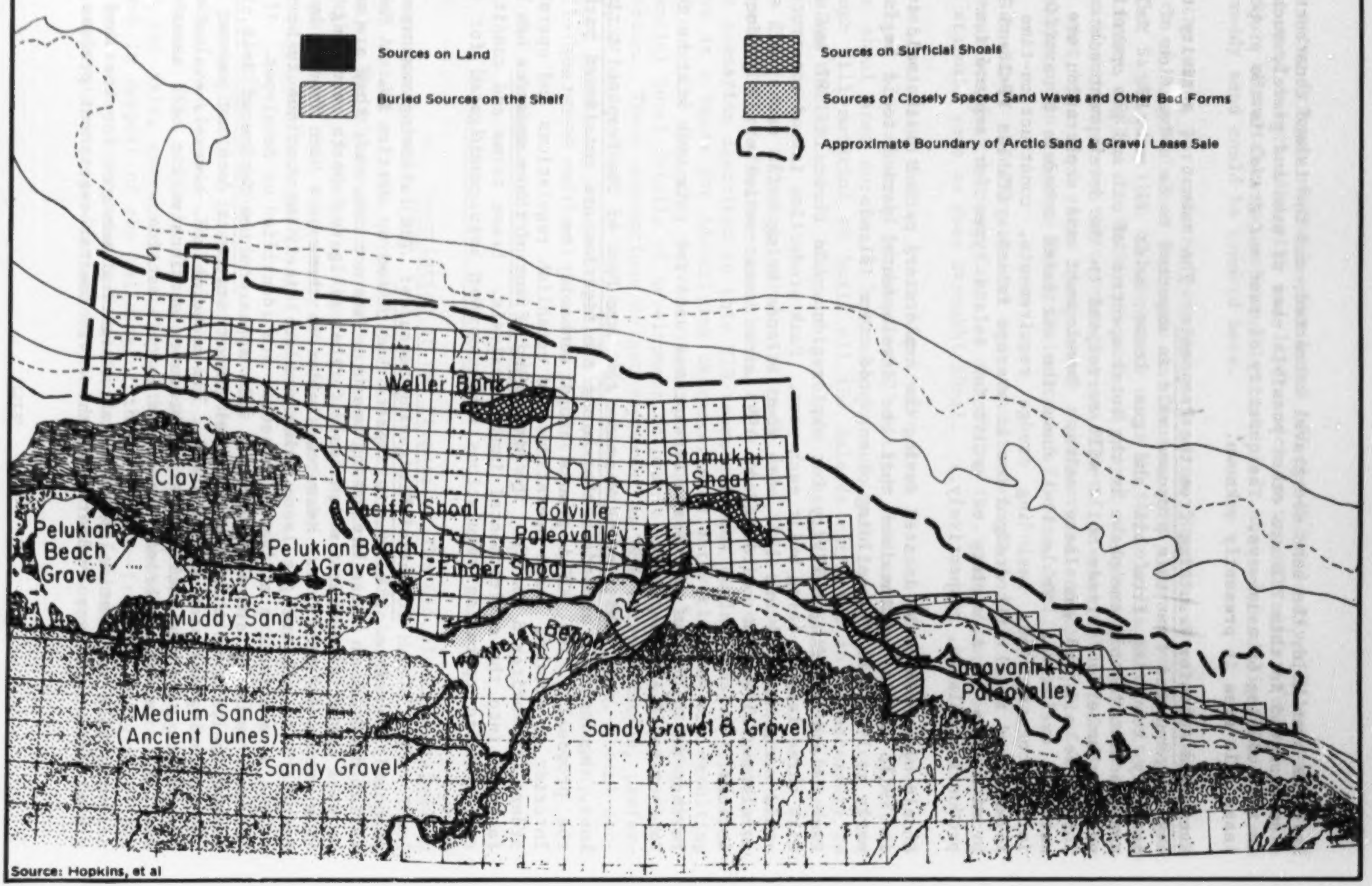
b. Mitigating Measures that are Part of the Proposed Action: Laws, regulations, or orders that provide mitigation are considered part of the proposal. The OCSLA grants broad authority to the Secretary of the Interior to control lease operations and establish regulations and operating orders (Appendices B and C). The mitigating effect of these measures has been factored into the environmental impact analysis. Lease terms and conditions and specific operating regulations have not yet been promulgated for this sale.

c. Potential Mitigating Measures: The following measures are proposed to reduce or eliminate impacts identified in Section IV. A Secretarial decision on these mitigating measures has not occurred; they are noted here as potential measures which could further mitigate impacts resulting from this proposed lease sale. Measures similar to these have been imposed by the Secretary in oil and gas lease sales and are likely to continue to be used unless more effective mitigating measures are identified or developed. If any of these measures are adopted, they will appear in the Notice of Sale. The impact analysis in this environmental impact statement does not assume that the following measures are in place. The measures are, however, evaluated in the Effect of Additional Mitigating Measures sections within each assessment (Sec. IV), as well as briefly described in this section.

All available information on potential mitigating measures for the sand and gravel lease sale was evaluated in the environmental assessment process. A

Figure II–1

Known Sources of Fill in and Near the Proposed Sand and Gravel Sale Area


Sources on Land
Buried Sources on the Shelf
Sources on Surficial Shoals
Sources of Closely Spaced Sand Waves and Other Bed Forms
Approximate Boundary of Arctic Sand & Gravel Lease Sale
Weller Bank
Stamukhi Shoal
Clay
Pacific Shoal
Colville Paleovalley
Pelukian Beach Gravel
Pelukian Beach Gravel
Finger Shoal
Muddy Sand
Two Meter Bench
Sagavanirktok Paleovalley
Medium Sand (Ancient Dunes)
Sandy Gravel & Gravel
Sandy Gravel

Source: Hopkins, et al

Table II-1
Artificial Island and Dredge Requirements for Activities Resulting from Oil and Gas Lease Sales BF and 71

Estimated Schedule of Artificial Island Construction[1]

Calendar Year	Exploration Islands	Production Islands	Operating Dredges[2]	Construction Time-Per Island (Days)	Total Fill Dredged[3] (Million Cubic Meters)
1983	1		1	28-60	5.96
1984	1	1	3	28-60	15.89
1985	2		2	28-60	11.93
1986	2		2	28-60	11.93
1987	3		3	28-60	17.35
1988	3		3	28-60	17.35
1989			0		
1990		3	6	24-50	29.80
1991		4	8	24-50	39.72
1992		4	8	24-50	39.72
Totals	12	12	NA		189.65

Source: MMS, Alaska OCS Region, 1982.

1/Includes only those islands which are constructed from offshore federal sources.

2/Assumes one dredge for each exploration island and two dredges for each production island. Dredge type is a 24-inch cutterhead dredge.

3/Dredged fill material volumes were derived from Tables II-2 and II-3 taking an average amount of fill between a 10-meter gravel natural-slope island and a 10-meter sand natural-slope island.

Table II-2
Exploration Islands-Generic Data

Depth in meters	Construction Material	Slope below water	Island Volume 1/		Dredge Volume 2/		Dredging Time (Days) 4/		
			$M^3 x10^5$	$YD^3 x10^5$	$M^3 x10^5$	$YD^3 x10^5$	16" CS 8,780 M^3/day	24" CS 21,400 M^3/day	32" CS 70,000 M^3/day
5	Gravel sandbagged to bottom	1/3	1.35	1.77	1.45	1.89	17	7	2
5	Gravel natural slope	1/6	1.54	2.01	1.65	2.15	19	8	2 ½ 6/
5	Sand natural slope	1/15	2.24	2.93	2.55	3.34	29	12	4 5/
5	Silt natural slope	1/30	3.90	5.10	4.72	6.17	54	22	7 5/
10	Gravel sandbagged to bottom	1/3	2.56	3.34	2.74	3.58	31	13	4
10	Gravel natural slope	1/6	3.45	4.51	3.69	4.83	42	17	5 ½
10	Sand natural slope	1/15	7.23	9.46	8.24	10.78	96 6/	39	12
10	Silt natural slope	1/30	17.43	22.79	21.08	27.58	240 6/	99	30
20	Gravel sandbagged to bottom	1/3	6.39	8.35	6.83	8.94	78 6/	32	10
20	Gravel natural slope	1/6	11.07	14.48	11.85	15.50	135 6/	55	17
20	Sand natural slope	1/15	34.03	44.51	38.79	50.74	442 6/	181 6/	55
20	Silt natural slope	1/30	103.25	135.05	124.94	163.41	1423 6/	586 6/	178
25	Caisson retained 3/ 16.5m caisson depth, 100m caisson diameter, sand pedestal and fill		13.76	18.00	15.68	20.52	179	73	22

1/ Assumes a 100-m diameter working surface, 5-m design freeboard with a 1/3 protected slope above the waterline.

2/ Assumes
- (1) 7 percent gravel, 14 percent sand, and 21 percent silt lost during construction to waves and current.
- (2) 5-10 percent of material will be lost due to compaction and settlement.
- (3) 5-10 percent of material will be gained through fluffing and bulking of dredge material.

3/ Volumes required for caisson-retained islands will vary depending on caisson dimension.

4/ Dredge times will increase if overburden must be removed and poor or rough weather conditions reduce production capacity of dredges. Note that average island construction time is twice the computed dredge time.
- (1) All dredges are operable for 20 hours per day.
- (2) Cutterhead suction dredges have direct pipeline discharge at island site.
- (3) Inch indications refer to pump capability of the dredge.

5/ It is unlikely that a 32" dredge would work at this depth.

6/ These figures are for comparison only. It is unlikely that any company would utilize a dredging method which would require more than 2 construction seasons to complete an exploration island.

Notes: (1) The term CS is an abbreviation for a type of hydraulic dredge known as a cutterhead suction dredge.

(2) The inch indications refer to the outflow pipe size.

(3) The power/capacity of a hydraulic dredge is rated by its outflow pipe size as well as its pump horsepower.

(4) The actual days listed which are needed to construct each island class are theoretical estimates based on dredge capacity and fill volumes. Actual experience in the Canadian Beaufort Sea has shown that due to weather, breakdowns, and other unforeseen difficulties, actual construction time for each island should be double that indicated in the table.

Source: Curtis and Murrell, 1982.

Table II-3
Production Islands-Generic Data

Depth in meters	Construction Material	Slope below water	Island Volume 1/ M^3x10^5	YD^3x10^5	Dredge Volume 2/ M^3x10^5	M^3x10^5	Dredging Time (Days) 4/ 16" CS 8,780 M^3/day	24" CS 21,400 M^3/day	32" CS 70,000 M^3/day
5	Gravel sandbagged to bottom	1/3	3.05	3.99	3.27	4.27	37	15 ½	4 ½
5	Gravel natural slope	1/6	3.32	4.34	3.55	4.65	40 ½	16 ½	5 5/
5	Sand natural slope	1/15	4.26	5.57	4.85	6.35	55 ½	22 ½	7 5/
5	Silt natural slope	1/30	6.31	8.26	7.64	9.99	87	35 ½	11 5/
10	Gravel sandbagged to bottom	1/3	5.35	7.00	5.72	7.49	65	26 ½	8
10	Gravel natural slope	1/6	6.55	8.57	7.01	9.17	80	33	10
10	Sand natural slope	1/15	11.27	14.74	12.85	16.81	146 6/	60	18 ½
10	Silt natural slope	1/30	23.06	30.16	27.90	36.50	317 6/	130	40
20	Gravel sandbagged to bottom	1/3	11.83	15.47	12.66	16.55	144 6/	59	18
20	Gravel natural slope	1/6	17.77	23.25	19.02	24.87	217 6/	89	27
20	Sand natural slope	1/15	44.49	58.20	50.72	66.34	578 6/	237 6/	73
20	Silt natural slope	1/30	120.07	157.05	145.29	190.04	1655 6/	679 6/	208
25	Caisson Retained 16.5 m caisson depth, 150m x 150m square sand pedestal and fill	1/15	25.17	32.92	28.67	37.50	329 6/	135 6/	41 1/2

1/ Assumes an elliptical surface dimension of 182m x 152m for non-caisson islands.

2/ Assumes
- (1) 7 percent of gravel, 14 percent of sand, and 21 percent of silt lost during construction to waves and current.
- (2) 5-10 percent of material will be lost due to compaction and settlement.
- (3) 5-10 percent of material will be gained through fluffing and bulking of dredged material.

3/ Volumes required for caisson-retained islands will vary depending on caisson dimension.

4/ Dredge times will increase if overburden must be removed or poor weather conditions reduce production capacity of dredges. Note that average island construction time is twice dredge time.
- (1) All dredges are operable for 20 hours a day.
- (2) Cutterhead suction dredges have direct pipeline discharge at island site.
- (3) Inch indications refer to pump capability of the dredge.

5/ It is unlikely that a 32" dredge would work at this depth.

6/ These figures are for comparison only. It is unlikely that any company would utilize a dredging method which would require more than 3 years to complete a production island.

Notes:

(1) The term CS is an abbreviation for a type of hydraulic dredge known as a cutterhead suction dredge.

(2) The inch indications refer to the outflow pipe size.

(3) The power/capacity of a hydraulic dredge is rated by its outflow pipe size as well as its pump horsepower.

(4) The actual days listed which are needed to construct each island class are theoretical estimates based on dredge capacity and fill volumes. Actual experience in the Canadian Beaufort Sea has shown that due to weather, breakdowns, and other unforeseen difficulties, actual construction time for each island should be double that indicated in the table.

Source: Curtis and Murrell, 1982.

field-level interdepartmental coordination meeting was held on October 7, 1982, to further discuss and evaluate potential measures, in accordance with established procedures. In attendance at the meeting were representatives from the Minerals Management Service and the U.S. Fish and Wildlife Service, and the Regional Environmental Officer. A second meeting of Washington Office and Anchorage MMS personnel was held October 19, 1982, to discuss and evaluate lease terms and conditions.

(1) Potential Stipulations:

The existing remote sensing data interpreted for cultural resource (a site, structure, or object of historical or archaeological significance) potential indicate little likelihood for survival of these resources in the lease sale area. Thus, at this time, there is no anticipated need to require cultural resource surveys.

> The lessee agrees that if any cultural resource should be discovered during conduct of any dredging operations on the lease area, he shall report immediately such findings to the RSFO (Regional Supervisor, Field Operations) and make every reasonable effort to protect the cultural resource from damage until the RSFO has given directions as to its protection.
>
> If the RSFO, Alaska Region, has reason to believe that a site, structure, or object of historical or archaeological significance (hereinafter referred to as a "cultural resource") may exist in the lease sale area and the RSFO gives the lessee written notice that the lessor is invoking the provisions of this stipulation, the lessee shall upon receipt of such notice comply with the following requirements.
>
> a) Prior to any dredging activity on the leasehold, the lessee shall conduct appropriate surveys and/or prepare a report as specified by the RSFO to determine the potential existence of any cultural resource that may be affected by such dredging. All data produced, including pertinent natural and cultural environmental data, shall be examined by an archaeologist and geophysicist to determine if indications are present suggesting the existence of a cultural resource that may be adversely affected by any dredging operation. A report of such surveys and assessment prepared by the archaeologist and geophysicist shall be submitted by the lessee to the RSFO for review.
>
> b) If such cultural resource indicators are present, the lessee shall (1) locate the site of such operation so as not to adversely affect the identified location; or (2) establish, to the satisfaction of the RSFO on the basis of further archaeological investigation conducted by a qualified archaeologist and geophysicist using such survey equipment and techniques as deemed necessary by the RSFO either that such operation shall not adversely affect the location identified or that the potential cultural resource suggested by the occurrence of the indicators does not exist.

c) A report of this investigation prepared by the archaeologist and geophysicist shall be submitted to the RSFO for review. Should the RSFO determine that the existence of a cultural resource which may be adversely affected by such operation is sufficiently established to warrant protection, the lessee shall take no action that may result in an adverse effect on such cultural resource until the RSFO has given directions as to its protection.

Anticipated Effect of this Measure: This measure would reduce the possibility of damage to or destruction of cultural resources within the proposed sale area through early identification of the resource.

Protection of Biological Resources

If biological populations or habitats which may require protection are identified by the RSFO on any tracts in the leasing area, the RSFO will require the lessee to conduct environmental surveys, as approved by the RSFO to determine the extent and composition of biological populations or habitats, and the effects of proposed or existing operations on the populations or habitats which might require additional protective measures. The RSFO shall provide written notice to the lessee of his decision to require such surveys. Such surveys will be required (unless previously performed) for the area known as the Boulder Patch, which applies to the following 13 blocks: 609, 610, 653-656, 698-701, 743, 744, and 788. For all other blocks within the lease sale area, the nature and extent of any surveys will be determined by the RSFO on a case-by-case basis.

Based on any surveys which the RSFO may require of the lessee, or other information available to the RSFO on special biological resources, the RSFO may require the lessee to: (1) locate the site of such operation so as not to adversely affect the resource identified; (2) establish to the satisfaction of the RSFO on the basis of a site-specific survey, either that such operation will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist; (3) operate during those periods of time that do not adversely affect the biological resources as established by the RSFO and/or (4) modify operations in such a way as not to affect adversely the significant biological populations or habitats deserving protection.

The lessee agrees that, if any area of biological significance should be discovered during the conduct of any dredging operations on the leased area, he shall immediately report such findings to the RSFO, and make every reasonable effort to preserve and protect the biological resource from damage until the RSFO has given the lessee directions with respect to its protection.

The lessee shall submit all data obtained in the course of such surveys to the RSFO with the locational information for dredging or other activity. The lessee may take no action that might result in any effect on the biologic populations or habitats surveyed, until the provides written directions to the lessee, with regard to permissible actions.

Known special biological resources and their habitats include hard and rocky bottoms with kelp, bryozoans, sponges, and coral, and could include other epibenthic communities.

Anticipated Effect of this Measure: Certain unique biological assemblages exist in the lease area in association with discontinuous hard or rocky bottom areas collectively known as the Boulder Patch. Dredging or island construction activities within or in close proximity to these habitats could result in irreversible loss or damage to these biological communities. While the extent of the hard or rocky bottom areas has been located and mapped, the extent of the important biological areas in association with these areas is not completely known. Additionally, other unique biological populations and habitats not yet identified may exist in the proposed lease area. This stipulation provides a mechanism to identify, delineate, and protect these resources. Enforcement of this stipulation would prevent irreversible loss or unnecessary damage to these unique biological communities.

Orientation Program

There is concern that uninformed workers and subcontractors could unknowingly destroy or damage the environment, be insensitive to local historical or cultural values, as well as biological resources, or unnecessarily disrupt the local economy. Due to the importance of subsistence, lifestyle, economics, and wildlife resources in the Beaufort Sea area, these issues would be covered in the proposed orientation program. These subjects have been identified in the scoping process as major concerns.

This potential mitigating measure should provide increased protection to the environment and addresses concerns of local residents. Similar programs were implemented for the Trans-Alaska Pipeline and in the lower Cook Inlet, Eastern Gulf of Alaska, and Beaufort Sea OCS lease sale areas.

> The lessee shall include in any dredging operation plans a proposed environmental training program for all personnel involved in such activities (including personnel of the lessee's contractors and subcontractors) for review and approval by the RSFO. The program shall be designed to inform each person working on the project of specific types of environmental, social, and cultural concerns which relate to the individual's job. The program shall be formulated by qualified instructors experienced in each pertinent field of study, and shall employ effective methods to insure that personnel are informed of archaeological, geological, and biological resources including bird colonies and mammal concentration areas, to insure the importance of avoidance and non-harassment of wildlife resources is understood. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The program shall inform personnel that subsistence activities are carried out year-round and throughout the area. Operations should be conducted so as to minimize interference with subsistence harvests.
>
> The lessee shall also submit for review and approval a continuing technical environmental briefing program for supervisory and managerial personnel of the lessee and its agents, contractors, and subcontractors.

Anticipated Effect of this Measure: This measure should have a positive mitigating effect in that it makes the workers aware of the unique environmental, social, and cultural values of the local residents and their environment. This orientation program would promote an understanding of and appreciation for local community values, customs, and lifestyles of Alaskans without creating undue costs to the lessee. It would also provide necessary information to personnel which could result in reduced behavioral disturbance to wildlife. This measure also serves to inform operators of the special concern for subsistence activities by residents in the Beaufort Sea area, thereby reducing the probability of adverse impacts. Subsistence and maintenance of lifestyle for the people of the North Slope are major issues of concern. Dependence on subsistence and village living are predominant in the area. Disturbance of subsistence harvest activities, particularly year-round sealing, fall whaling, and fishing, could seriously disrupt the lifestyle, culture, and social organization of villages in the Beaufort Sea area.

Information on Subsistence Activities

Lessees are advised that operations should be conducted so as to minimize interference with subsistence harvests.

Anticipated Effect of this Measure: This measure should serve to inform operators of the special concern for subsistence activities by residents in the Beaufort Sea area, thereby reducing the probability of adverse impacts. Subsistence and maintenance of lifestyle for the people of the North Slope are major issues of concern. Dependence on subsistence and village living are predominant in the area. Disturbance of subsistence harvest activities, particularly year-round sealing, fall whaling, and fishing, could seriously disrupt the lifestyle, culture, and social organization of villages in the Beaufort Sea area.

Information on Bird and Marine Mammal Protection

Bidders are advised that during the conduct of all activities related to leases issued as a result of this lease sale, the lessee and its agents, contractors, and subcontractors will be subject to, inter alia, the provisions of the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, and International Treaties.

Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harassment, and thereby be in violation of existing laws. Violations under these acts and treaties must be reported to the National Marine Fisheries Service or U.S. Fish and Wildlife Service, as appropriate. Behavioral disturbance of most birds and mammals found in or near the proposed arctic sand and gravel sale would be unlikely if marine vessels and aircraft maintained at least a 1-mile distance from observed wildlife or known wildlife concentration areas such as bird colonies or marine mammal concentrations. Therefore, it is recommended that aircraft or vessels operated by lessees maintain at least a 1-mile distance from observed wildlife or known wildlife concentrations.

To reduce potential impacts to bowhead whales from effects of noise and disturbance associated with dredging activities, lessees are encouraged to reduce, minimize, or reroute marine vessel operations to and from the leasehold by tugs, barges, supply ships, hovercraft, or other self-propelled surface vessels when bowhead whales are likely to be in the area (normally September 1 through October 31). Lessees are advised that operations may be restricted or suspended, if appropriate, by the RSFO on any lease in the lease sale area whenever bowhead whales are present in the area or near enough to be subject to disturbance from dredging activities which would be likely to jeopardize the endangered species. Information on general locations of bowhead whales will be provided by the Department of Interior bowhead monitoring program(s).

For protection of bowhead whales throughout the proposed lease sale area, operators of fixed-wing aircraft or helicopters should maintain a 1,500 foot altitude (except during take-off and landing) when in transit over the leasing area generally during the period September 1 to October 31.

If non-endangered/non-threatened marine mammals are likely to be affected by sand and gravel operations, lessees and their contractors should be aware that their activities may require consultation with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service pursuant to 16 U.S.C. 1371(a)(5).

Maps locating major wildlife concentration areas are available for route planning from the RSFO and appropriate resource agencies. Human safety will take precedence at all times over these provisions.

Anticipated Effect of this Measure: Conformance by lessees with the recommendations described above should help to ensure that behavioral disturbance of wildlife, particularly at known concentration areas, would be minimized. Maps provided to the RSFO would clearly designate locations habitually used as concentration areas. Tract-specific recommendations may be made by the RSFO as appropriate. Appropriate authorities may issue more specific regulations under existing legislation that could further reduce behavioral disturbance to wildlife.

Information on Biological Task Force

In the enforcement of the Protection of Biological Resources stipulation, the RSFO will receive recommendations from a biological task force composed of designated representatives of the Minerals Management Service, U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Environmental Protection Agency. In forming their recommendations, the BTF will consult with the State of Alaska (a non-voting member). The RSFO will consult with the task force on the conduct of biological surveys by lessees, the appropriate course of action after surveys have been conducted, and on the administration of the biological/environmental aspects of the above-mentioned stipulation.

Anticipated Effect of this Measure: Involvement of the Biological Task Force in the enforcement of the "Protection of Biological Resources" stipulation could help ensure that surveys and/or study designs and results are adequate to delineate the extent and composition of sensitive biological populations and habitats. The BTF will be available to the RSFO to render guidance concerning these resources and to help resolve any undefined points within it should questions arise. Further, the BTF is available to provide recommendations for mitigating adverse effects to these resources.

Information on Corps of Engineers Permits

Corps of Engineers permits are required for work in navigable waters and construction of artificial islands on the OCS in accordance with §4(e) of the OCS Lands Act of 1953, as amended and §10 of the River and Harbor Act of 1899.

Anticipated Effect of this Measure: The responsibility of the Corps is to consider factors regarding navigation and national security in OCS waters. This measure will alert potential lessees to the need to obtain Corps of Engineers permits.

Information on Coastal Zone Management

Lessees are advised that coastal management policies may relate to activities associated with offshore mining. Lessees may wish to consult with the State agencies involved in coastal management review and the North Slope Borough in order to provide coordination and assure consistency with the state coastal management program. Lessees should be advised that the North Slope Borough is preparing a district coastal management program and should complete it in 1983.

Appropriate agencies to contact include the North Slope Borough, the Alaska Office of Coastal Management, the Federal Office of Coastal Management, U.S. Fish and Wildlife Service, Alaska Department of Natural Resources, and the Alaska Department of Community and Regional Affairs.

Anticipated Effect of this Measure: Conformance by lessees with this recommendation could help to ensure that coastal zone management regulations are met. The intent of the recommendation is to suggest that activities occurring within or outside the coastal zone be consistent with the coastal management program. This could help to minimize potential adverse impacts and prevent costly delays in development. Appropriate authorities may issue more specific regulations under existing legislation that could further assist proper placement of OCS facilities offshore and nearshore.

d. Other Mitigating Measures Beyond DOI Authority: CEQ regulations implementing NEPA require lead agencies to consider mitigating measures beyond the authority of both the lead and cooperating agencies (40 CFR 502.16(h), 1505.2(c); clarified at 46 FR 18031-18032). Other mitigating measures comprise potential regulations, projects, plans, and operating practices which may function as mitigating measures in the context of this EIS. These measures may be beyond the authority of the Department of the Interior. See Technical Paper No. 4 (Casey, 1981) and Appendices B and C for a list and discussion of these measures.

e. Summary of Probable Impacts: The probable impacts are based on the assumption that sand and gravel will be leased, extracted, and removed, and that about 12 exploratory and 12 production artificial islands will be built of fill material from OCS submerged land in support of exploration for, and development of oil and gas resources throughout areas leased in sales BF and 71. Assumed sand and gravel needs are about 190 million cubic meters of fill material. It is also assumed that there is sufficient fill material in the proposed sale area to satisfy these needs. Dredges are the assumed method of mining and barges, pipelines, and hopper dredges provide the means of transporting fill to the deposition site. See Section IV.A. for further detail.

The following discussion assumes that all laws, regulations, and orders are part of the proposal. If the proposed mitigating measures described in Section II.B.1.c. were adopted, it is expected that some impacts described in this environmental impact statement would be reduced. Potential effectiveness of the mitigating measures is described in each impact section. Impact analysis does not assume lease terms and conditions or operating orders for this sale.

Population-induced impacts assessed to the proposal are expected to be minor and short-term. Offshore mining operations are quite self-contained. Crew changes may or may not be made and if made, the only contact on the North Slope would be in the Prudhoe Bay airport. Islands and other facility construction using OCS mined material may continue as long as hydrocarbons are produced from the area. However, because of the 2- to 2½-month open-water period yearly dredging operations are a short-lived phenomenon.

Social systems impacts most likely to occur with gravel leasing on the OCS depend on the type of contacts or disturbance most likely to occur with dredging operations, crew and subsistence species utilized locally. Minor effects on North Slope Borough political systems, in the form of changing attitudes, increased coordination time and staffing, and increased air and marine transport contact through Prudhoe Bay-Deadhorse can be expected. Potential disturbance of subsistence whaling, sealing, fishing, and birding which is carried out near the barrier islands of Flaxman, Cross, Pingok, Tiguigiaq, Pole, and Foggy could have region-wide significance. Proposed mining activities will not be closer than 4.8 kilometers (3 miles).

Mining activities on the OCS will involve the use of dredges and some sort of depositional method. The primary impact of these activities is a decrease in water quality, but because the Beaufort Sea bottom sediments are uncontaminated, this decrease would be meaningless. However, the expression of impact is in the effects water quality change has on the biological populations in the affected area.

Dredging and island construction operations conducted within the Boulder Patch areas of Stefansson Sound would result in permanent or long-term damage to this diverse community. The ecological ramifications of such damage are unknown; however, a significant reduction in biomass and species diversity would result in areas disturbed by dredging or covered by artificial islands. This could be a major adverse impact.

Dredging and island construction operations conducted in areas outside and adjacent to the Boulder Patch would result in short-term, negligible impacts if operations are located a safe distance upstream (greater than 600 meters).

For the most part, significant adverse impacts to fish and epibenthic invertebrates are not expected from turbidity from any mining or deposition activity.

Given that most fish and certain epibenthic invertebrates are mobile, it is reasonable to assume that some of these organisms could escape the relatively small, turbid area created by a dredging operation. Also, these organisms, especially the sessile epibenthic forms, are occasionally exposed to naturally occurring suspended sediment concentrations approaching or greater than expected from the dredging operations.

Entrainment of organisms in the dredging device would likely result in direct mortality for most of the organisms entrained. Benthic organisms entrained from the area of excavation would suffer the greatest mortality, while fish mortalities would be minor.

Resuspension of trace metals and other pollutants in toxic proportions is not anticipated. The lease area is considered pristine with very low, naturally occurring accumulations of heavy metals in the bottom sediments. Therefore, no effects to the biotic community from metal assimilation are expected.

Dredging and gravel island construction operations resulting from the proposal could produce major local adverse impacts on benthic invertebrates. Local impacts to fish and plankton would be minor. Such impacts would include loss and disturbance of up to 47 square kilometers of benthic habitat, direct mortality by smothering or entrainment, and a reduction in primary productivity. Most, if not all, of these harmful effects would be restricted to the immediate vicinity of each construction or dredging area, with recolonization occurring within a short period (less than 5 years).

Displacement and other disturbance of marine and coastal birds, temporary local reduction in prey species and prey habitat associated with dredging and island construction are likely to cause minor short-term and negligible long-term local population and distribution reductions of marine and coastal birds. Significant, long-term regional impacts as a result of the proposal are very unlikely.

Displacement and other disturbance of marine mammals, local reduction in prey species and benthic habitat associated with dredging and island construction are likely to cause minor short-term and negligible long-term local population and distribution reductions of marine mammals in the proposed lease area. Significant long-term regional impacts on marine mammals are very unlikely as a result of the proposal.

Gray whales might possibly react to certain types of acute and localized disturbances associated with dredging activities (increased vessel traffic, increased low' frequency noises). However, the existing information base suggests strongly that the types and levels of noise and disturbance associated with dredging and deposition activities in arctic environments will not create a significant adverse impact on this population. Short-lived and local impacts, however, might be expected in the western Beaufort Sea region specific to gray whale interaction with proposed sand and gravel leasing areas.

The most likely potential effects on bowhead whales due to the proposed action include the uncertain amount of but anticipated increase in noise and disturbance from increased vessel, dredging, and aircraft traffic associated with the proposed action. Potential effects due to physical barriers (gravel islands, barges, ships), low frequency dredging noises, and increased turbidity are not expected to adversely affect the bowhead whale population within the proposed lease sale area.

Increased vessel noises associated with the proposed action are likely to affect a few bowhead whales during the fall migration period. The ultimate long-term effect of disturbance may be abandonment of a particular area, and possibly reduced productivity and population size. However, long-term behavioral effects from increases in noise and disturbance from vessel activities are unknown. Short-term behavioral effects in the vicinity of the proposed sale area from the increases in noise and disturbance can be expected. These effects (most probably a brief flight response) however, would not preclude a successful migration, although localized changes in migratory routes could be possible. Impacts on the overall population are most likely minor and short-term in duration.

2. Alternative II - No Sale:

a. Description of the Alternative: The total area would not be leased; however, subsequent activities as described for the proposal would occur. Should this alternative be selected, the Secretary of the Interior would need to make some other method of obtaining fill material from OCS submerged lands available to oil and gas lessees. The standard OCS oil and gas lease gives the lessee

> "the right to construct or erect and to maintain within the leased area artificial islands, installations, and other devices permanently or temporarily attached to the seabed and other works and structures necessary to the full enjoyment of the lease, subject to compliance with applicable laws and regulations."

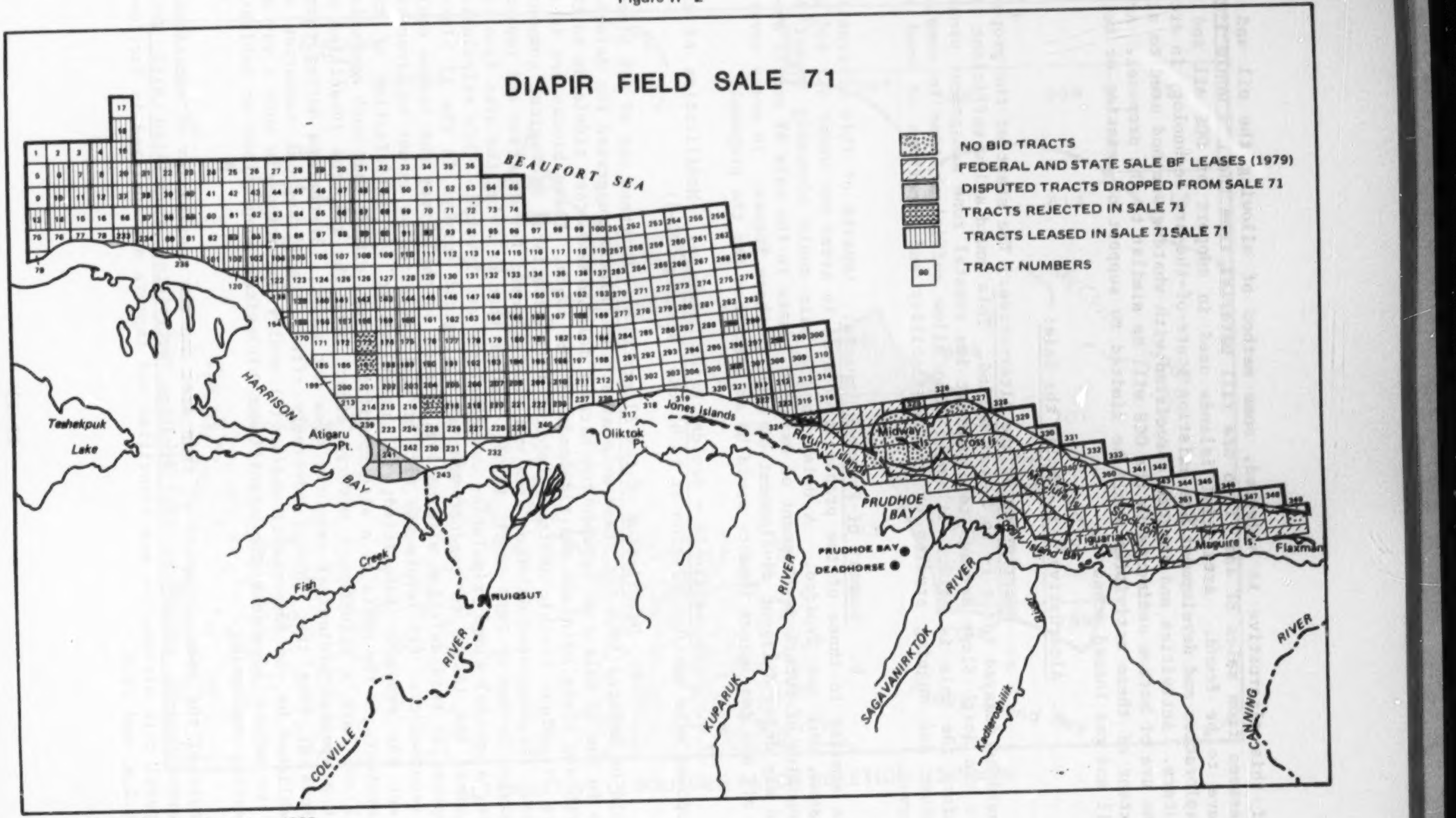
The lease also requires that

> "the Lessee shall drill such wells and produce at such rates as the Lessor may require in order that the leased area or any part thereof may be properly and timely developed and produced in accordance with sound operating principles."

Activities would be confined to oil and gas leased areas which comprise about 24 percent of the proposed sand and gravel lease sale area (Fig. II-2). Some sort of leasing activity would need to be carried out before the other blocks could be mined for sand and gravel.

b. Summary of Probable Impacts: Environmental impacts described in the proposal would be eliminated from the tracts not leased for oil and gas. Adverse impacts to the economics of diligent development of existing oil and gas leases could range from low (where other sources of fill are available and/or other means of allowing extraction are permitted) to severe (where other sources of fill are not available and/or other means of allowing extraction are not permitted). This could put some leases issued in sales BF and 71 in jeopardy. In addition, some oil and gas prospects may not be developed because this proposal would either eliminate materials necessary for field development or increase costs to a point where development of prospects are not economically feasible.

Figure II–2


DIAPIR FIELD SALE 71
NO BID TRACTS
FEDERAL AND STATE SALE BF LEASES (1979)
DISPUTED TRACTS DROPPED FROM SALE 71
TRACTS REJECTED IN SALE 71
TRACTS LEASED IN SALE 71SALE 71
TRACT NUMBERS
BEAUFORT SEA
Teshekpuk Lake
HARRISON
Atigaru Pt.
BAY
Fish Creek
NUIQSUT
COLVILLE RIVER
Oliktok Pt.
Jones Islands
Return Islands
KUPARUK RIVER
PRUDHOE BAY
PRUDHOE BAY
DEADHORSE
SAGAVANIRKTOK RIVER
Kadleroshilik
Midway Is.
Cross Is.
McClure Is.
Tigvariak
Foggy Island Bay
Maguire Is.
Flaxman
CANNING RIVER

Source: MMS Alaska OCS Region, 1982.

If this alternative is selected, some method of allowing the oil and gas lessees from sales BF and 71 to use fill material from the OCS would likely have to be found. Artificial islands used in support of OCS oil and gas exploration and development are existing state-of-the-art technology in arctic waters. Activities and impacts associated with whatever method used to allow the use of bottom sediments in the OCS will be similar to the proposal. Areal extent of these activities would be limited to support of existing or future oil and gas leased areas.

3. Alternative III - Delay the Sale:

a. Description of the Alternative: The start of the proposal would be delayed for a 1- to 2-year period. This would allow sufficient time for the North Slope Borough to implement its coastal zone management program before the sale is held. It would also allow sufficient time to complete future and ongoing studies of the availability and locations of sand and gravel.

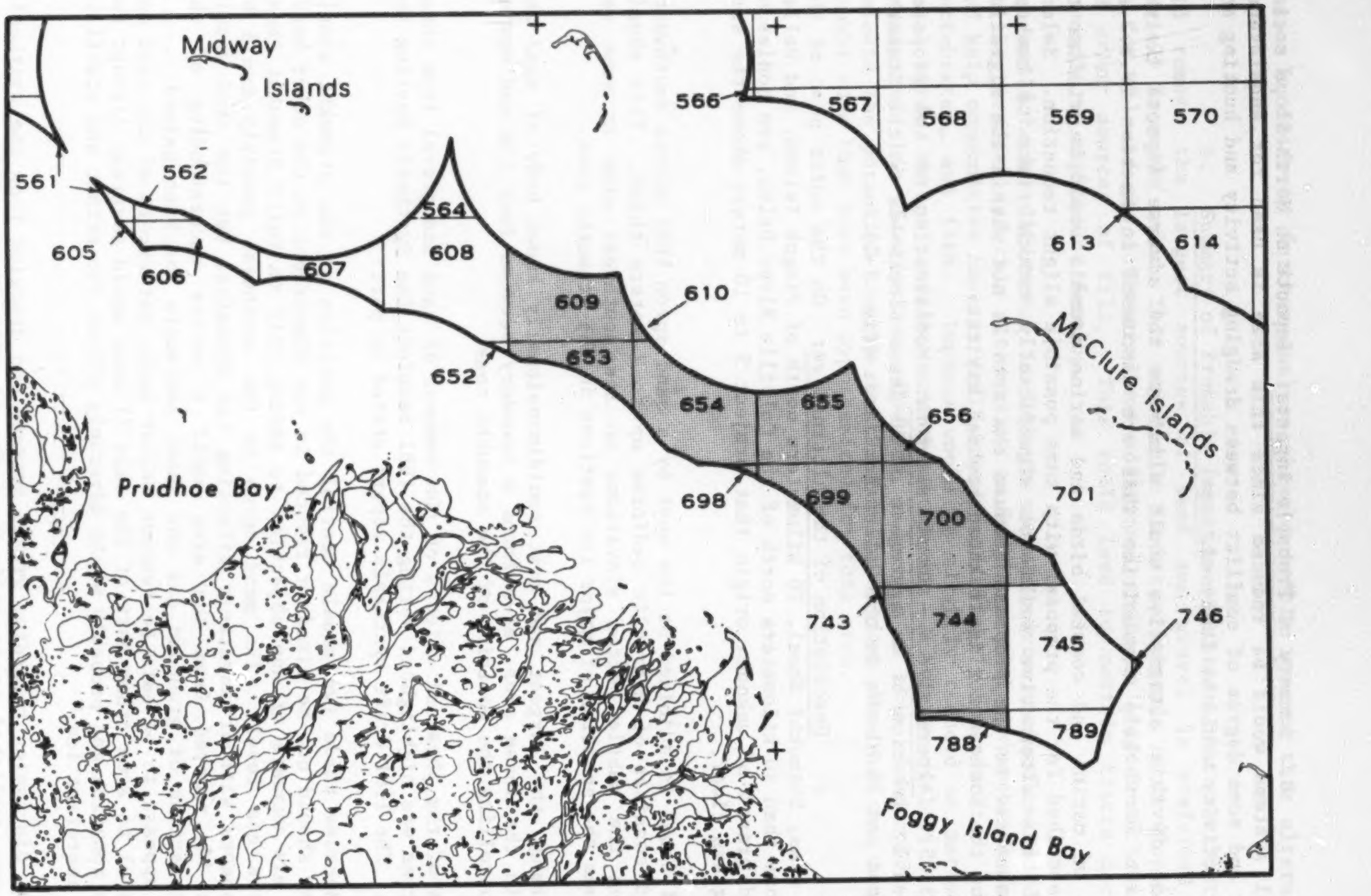
b. Summary of Probable Impacts: Impacts of this alternative are similar to those of the proposal; delayed in areas not under oil and gas leases, but not avoided. A delay in the sale could adversely impact the economics of future development of existing leases in the sale BF and 71 areas and may delay diligent development of some of those leases. In areas covered by oil and gas leases impacts would be as described for the proposal.

4. Alternative IV - Boulder Patch Deletion: Modification of the proposed sale area by deletion of 13 blocks (See Fig. II-3).

a. Description of the Alternative: Thirteen out of 616 blocks would be deleted from the lease sale area. The blocks suggested for deletion are in the BF sale area between the barrier islands and state tidelands to the north and state mainland and tidelands to the south. These blocks are in an area of unique benthic (bottom) habitat with associated biological communities. The suggested deletion area was also proposed for deletion and impacts analyzed in the BF FEIS (USDI, 1979). Rather than deleting the area from the sale, a special lease stipulation was developed and invoked. This stipulation required the lessee to conduct special biological surveys in the 13 blocks proposed in this deletion alternative. Based on the survey the lessee could be required to: (1) locate the site of such operation so as not to adversely affect the resource identified; (2) establish to the satisfaction of the Supervisor, on the basis of a site-specific survey, either that such operation will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist; (3) operate during those periods of time that do not adversely affect the biological resources as established by the Supervisor; and/or (4) modify operations in such a way as not to affect adversely the significant biological populations or habitats deserving protection.

Because of the special nature of this area and the possibility of additional adverse impacts caused by the dredging activities associated with this proposal this alternative was identified and impacts are analyzed in Sections IV.B.2.a. and IV.E.

Figure II–3


Midway Islands
566
567
568
569
570
561
562
564
605
606
607
608
613
614
609
610
652
653
McClure Islands
654
655
656
Prudhoe Bay
698
699
700
701
743
744
745
746
788
789
Foggy Island Bay

ALTERNATIVE IV BOULDER PATCH DELETION (13 Blocks)

Source: MMS AK OCS Region, 1982.

b. Summary of Probable Impacts: Impacts on North Slope sociocultural systems would be reduced since this area is used for subsistence harvest and some degree of conflict between dredging activity and hunting and fishing activity would be lessened.

Selection of this alternative would eliminate the adverse impacts to the Stefannson Sound kelp communities that are discussed in Section IV.B.2.a.

Impacts on marine and coastal birds and marine mammals would be similar to those described for the proposal with some possible slight reduction. Selection of this alternative would not significantly reduce risks to bowhead whales assessed to the proposal because the area is not within the migration routes of the bowhead nor is it known bowhead habitat.

5. Alternative V - Shoal Deletion: Modification of the proposed sale area by deletion of an aggregate of 30 lease blocks--12 in the Stamukhi Shoal area and 18 blocks in the Weller Bank area (Fig. I-1).

a. Description of the Alternative: On the outer part of the sale 71 area, Stamukhi Shoal, 20 kilometers north of Pingok Island, and Weller Bank, more than 40 kilometers north of the Colville River Delta, are bodies of sand and gravel of unknown origin that project 5 to 10 meters above the surrounding sea floor.

Stamukhi Shoal is adjoined on the west by a sand apron that curves southwestward and consists of hydraulic bedforms up to 2 meters thick. This shoal, including the subtle bottom elevations on its southwest side in some way determines the position of major ice bastions in the stamukhi zone.

Weller Bank, the largest and most equidimensionally known body of sand and gravel in the lease area, also forms a boundary between fast ice and moving ice, controlling the position of the stamukhi zone.

Analysis of the physical effects of the removal of sand and gravel from these shoal areas was highlighted during the 1981 Beaufort Sea Synthesis Meeting for sale 71. The 1981 draft synthesis report stated in part:

> "[Because these two shoals control the position of the stamukhi zone], they should not be mined or reduced in any dimension; on the other hand, we are unaware of any objection to adding fill to build Stamukhi Shoal above sea level. The sand apron to the southwest possibly could be reshaped without adversely affecting ice dynamics, but the sand should not be removed from the area until a better understanding of the interaction of grounded ice and shoal sediments has been gained. . . . It appears to be safe to reshape Weller Bank, but export of the sand and gravel to some other part of the sale 71 area would severely disrupt the ice zonation and probably would adversely affect the extent and stability of shorefast ice."

The total discussion regarding gravel sources and dredging from the synthesis meeting was published as Appendix D of the 71 FEIS (USDI, 1982). The preliminary draft of the 1982 Geological Survey report: Sand and Gravel on the Beaufort Sea Shelf: Resources and Environmental Considerations for Sand and Gravel Mining contains the same concern regarding dredging from these two areas. In order to further analyze these possible impacts this alternative was developed.

b. Summary of Probable Impacts: Deletion of these 30 tracts could remove the largest sources of sand and gravel (a preferred fill material) from the sale. This may result in less diligence in developing the area for oil and gas activities and additional costs to lessees of having to find other sources of fill. This could lead to certain tracts becoming uneconomic to explore or develop.

There would be no difference in impacts assessed from activities associated with the proposal and this alternative on Inupiat social systems. Stefansson Sound kelp communities impacts would be reduced slightly for plankton, benthic invertebrates, and fish. Impacts would be slightly reduced on marine and coastal birds, marine mammals, endangered species, and water quality with the selection of this alternative. However, selection of this alternative could eliminate the potential changes to the current regime, landfast ice zone, or stamukhi zone that have been hypothesized for this area.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

> [illegible]

[illegible]

III.

DESCRIPTION OF THE AFFECTED ENVIRONMENT

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. Physical Characteristics of the Beaufort Sea

1. Environmental Geology:

a. **Marine Sediments:** The Alaskan Beaufort Sea continental shelf is a relatively narrow feature, about 80 kilometers (50 miles) wide, and has generally low relief out to the shelf break which occurs at a depth of about 70 to 75 meters (230-248 ft).

The continental shelf is a seaward extension of the Arctic Coastal Plain physiographic province. This province is characterized by low relief, thousands of thaw lakes, many rivers and streams, and numerous other geomorphic features that are typical of arctic permafrost terrain. The coastal area contains river deltas, beaches, bluffs (which are thermally eroding), bays, lagoons, offshore and barrier islands, and other features of erosional and depositional shorelines. These many geomorphic forms and their constituents provide an indication of the features and sediment types which may occur on the shelf. During the Quaternary Period the present day shelf and coastal plain were subject to many of the same environmental conditions.

The oldest Quaternary sediments of the coastal plain and shelf belong to the Gubic Formation. This geologic time unit was formed by depositional and erosional processes during the transgressive and regressive sea level cycles that took place sometime after 1,900,000 to 700,000 years before the present (Hopkins, 1967). Onshore exposures of the Gubic Formation indicate that it consists mostly of marine sediment but locally fluvial (river), lacustrine (lake) or eolian (wind) deposits may predominate. The textural characteristics of the Gubic Formation range from poorly-to-well-sorted clay, silt, sand, and gravel deposits. These sediments were, for the most part, derived from sources to the south in the Brooks Range. Distribution of the Gubic Formation on the arctic coastal plain is described by Hopkins and Hartz (1978) and Rodeick (1979). The Gubic Formation is the most important geologic unit on the north slope of Alaska for sand and gravel (Briggs, 1982).

The other Pleistocene time-strategraphic unit that has been identified is the Flaxman Formation. Although the age has not been definitely determined, the Flaxman Formation was probably formed during the early part of the Wisconsin Age (Smith et al., 1980); this age occurred sometime between 100,000 and 48,000 years before the present (Hopkins, 1967). The Flaxman Formation is a glaciomarine deposit consisting of fine grained sediments and abundant glaciated pebbles, cobbles, and boulders that are lithologically different from similar size rocks derived from the Brooks Range. The mineralogy of these rocks indicates that they derived from provences to the east, perhaps in the vicinity of Amundsen Gulf in the Canadian Archipelago. Icebergs and ice islands that calved from the glaciers covering the region transported the rocks westward where they were deposited contemparaneously with sediments supplied by north flowing rivers and by coastal erosion. Exposures of the Flaxman Formation are indicated by Hopkins and Hartz (1978) and Rodeick (1979).

Based on publically available information, the sediment resources of the Alaska Beaufort Sea continental shelf are, for the most part, poorly known when evaluated as construction material; this is especially true when trying to determine the quantity of specific sediment size classes. An assessment of the amount of data presently available to make such evaluations is shown in Figures III-1 and III-2. However, sediment resource evaluation is only one aspect of the many investigations that directly or indirectly have been studying the factors effecting sedimentation on the continental shelf. From these studies the general and many specific characteristics of the shelf sediments have been determined and are summarized in the following discussion. These characteristics can be used to determine potential dredging sites.

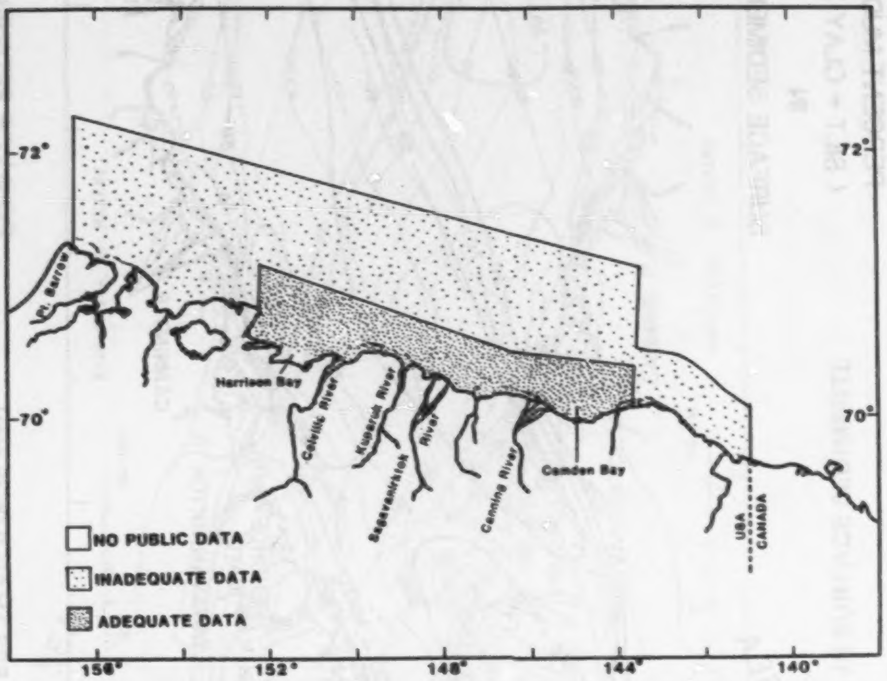
The general characteristics of the surface sediments of the Alaskan Beaufort Sea continental shelf are shown in Figures III-3, III-4, III-5, and III-6. In terms of size classes, these figures indicate that mud is the most common constituent, especially for those sediments in the central and outer parts of the shelf. Sand- and gravel-size particles are also present throughout the shelf environment and are more common in the nearshore and shallow water offshore areas. Also, the figures show a greater lateral variability of sediment types on the inner shelf than on the central or outer shelf. The diversity of sediment types between Cape Halkett and Brownlow Point is seen in Figures III-7A and III-7B.

The present day, or recent, sediments consist predominantly of material supplied by streams and rivers which rise in the foothills and mountains to the south and flow across the arctic coastal plain (Naidu, 1974). Fifty to eighty percent of the yearly discharge of the rivers occurs during a 2- to 3-week breakup period in June and the bulk of the river sediment load is associated with this flood (Barnes and Reimnitz, 1980). Fine sand-, silt-, and clay-size particles are carried into the marine environment, but the rivers and streams lack the competency to transport coarse sand- and gravel- size material beyond the fluvial environments (Hopkins and Hartz, 1978). Most of the sediment carried by the Colville River, the largest river in Arctic Alaska is fine sand and silt (Walker, 1974). Short cores, less than 2 meters (6.5 ft) taken on the deltas of the Colville, Kuparuk, Sagavanerktok, and Putuligayuk Rivers showed the following characteristics; (1) well stratified sediments with abundant fibrous organic matter, (2) bedded and cross-bedded clean sands, especially inshore of the 2-meter (6.5 ft) isobath, (3) the presence of sand as the coarse fraction component, and (4) the absence of gravels (Barnes, et al., 1979).

Thermal erosion of the coastal bluffs also supplies fine-grained sediment to the marine environment (Naidu and Mowatt, 1974 and Hopkins and Hartz, 1978). However, as indicated by the rate of coastal erosion, the amount of marine sediment derived from the erosion of the coastal bluffs varies not only with time but from place to place. Between Demarcation Point and the Colville River, coastal retreat averages about 1.6 meters (5 ft) per year, but higher short-term rates have been observed. The average rate of coastal retreat is highest, approximately 4.7 meters (15 ft) per year from Harrison Bay to Barrow, but short-term rates as great as 27 meters (90 ft) per year have also been observed. The fine-grained particles are washed into the marine environment, but the coarse-grained material remains on the beaches below the bluffs and forms lag deposits.

Ice which forms in the shallow marine and estuarine environments usually contains resuspended sediments that are entrapped as the water freezes. Barnes

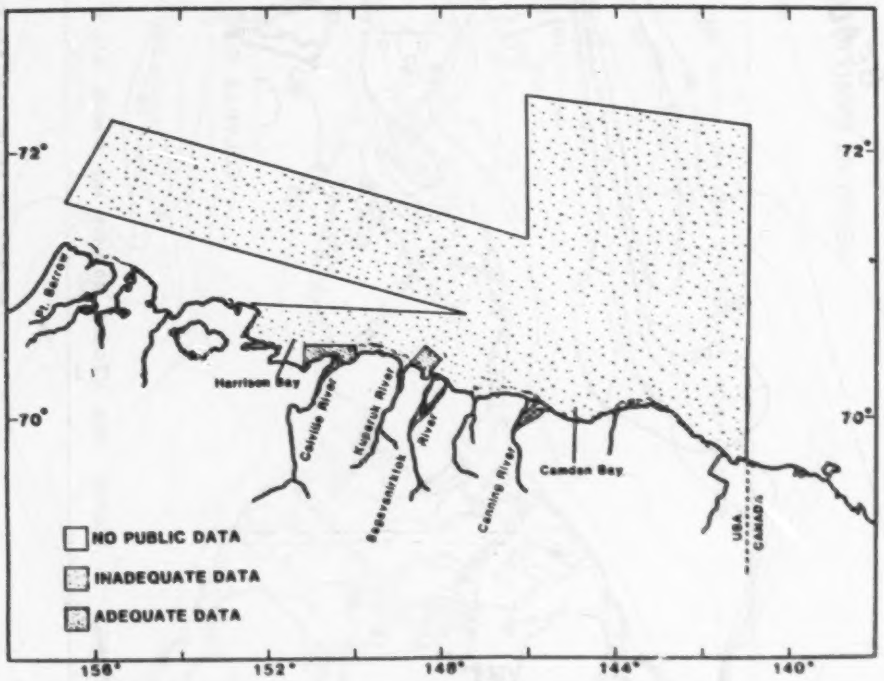
Figure III - 1



72°
72°
Pt. Barrow
Harrison Bay
Colville River
Kuparuk River
Sagavanirktok River
Canning River
Camden Bay
70°
70°
USA
CANADA
NO PUBLIC DATA
INADEQUATE DATA
ADEQUATE DATA
156°
152°
148°
144°
140°

APPROX. BOUNDARIES OF DATA COVERAGE FOR THE APPRAISAL OF SURFACE DEPOSITS, SAND & GRAVEL

Figure III - 2

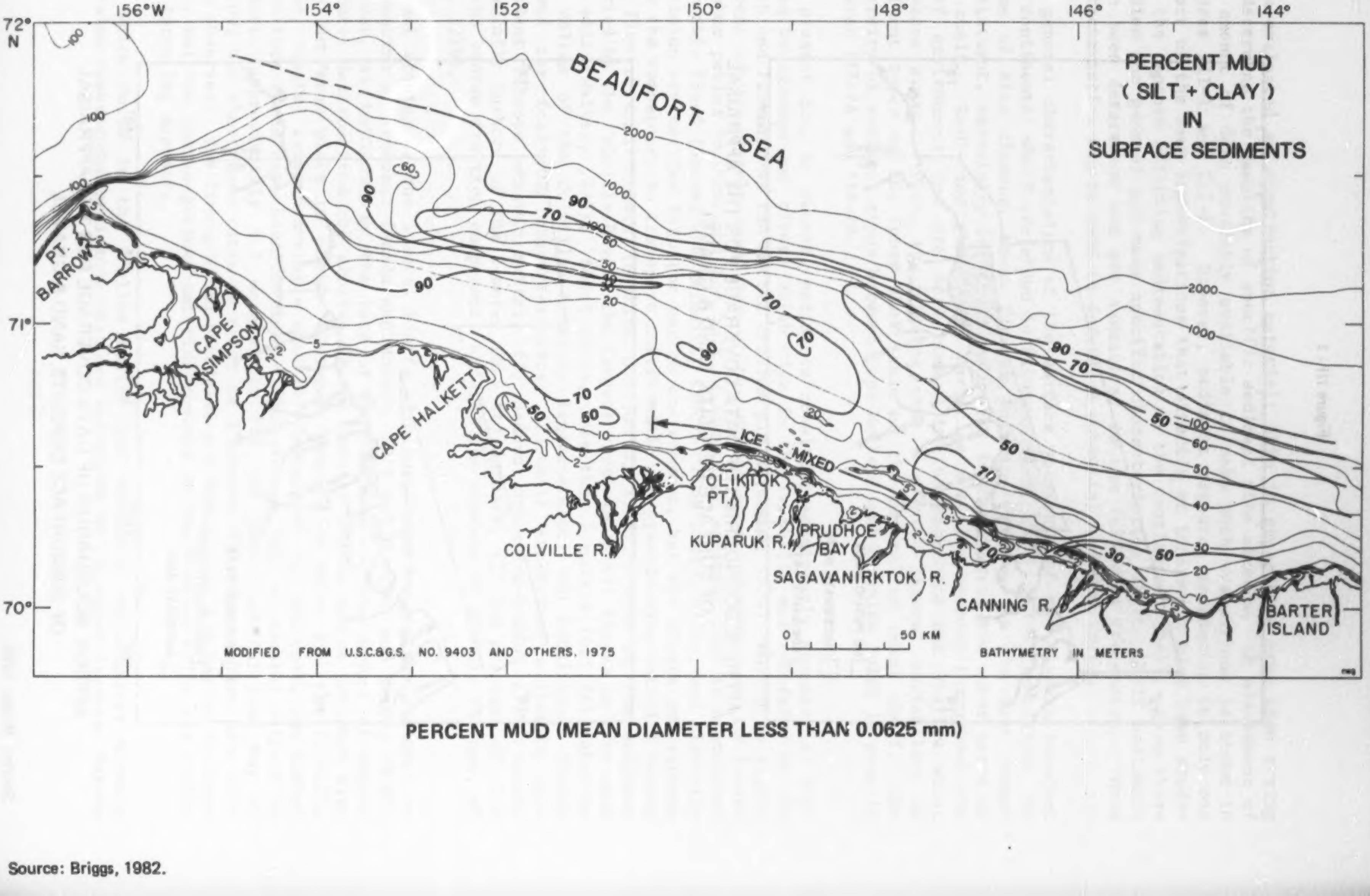


72°
72°
Pt. Barrow
Harrison Bay
Colville River
Kuparuk River
Sagavanirktok River
Canning River
Camden Bay
70°
70°
USA
CANADA
NO PUBLIC DATA
INADEQUATE DATA
ADEQUATE DATA
156°
152°
148°
144°
140°

APPROX. BOUNDARIES OF DATA COVERAGE FOR THE APPRAISAL OF SUBSURFACE DEPOSITS, SAND & GRAVEL

Source: Briggs, 1982.

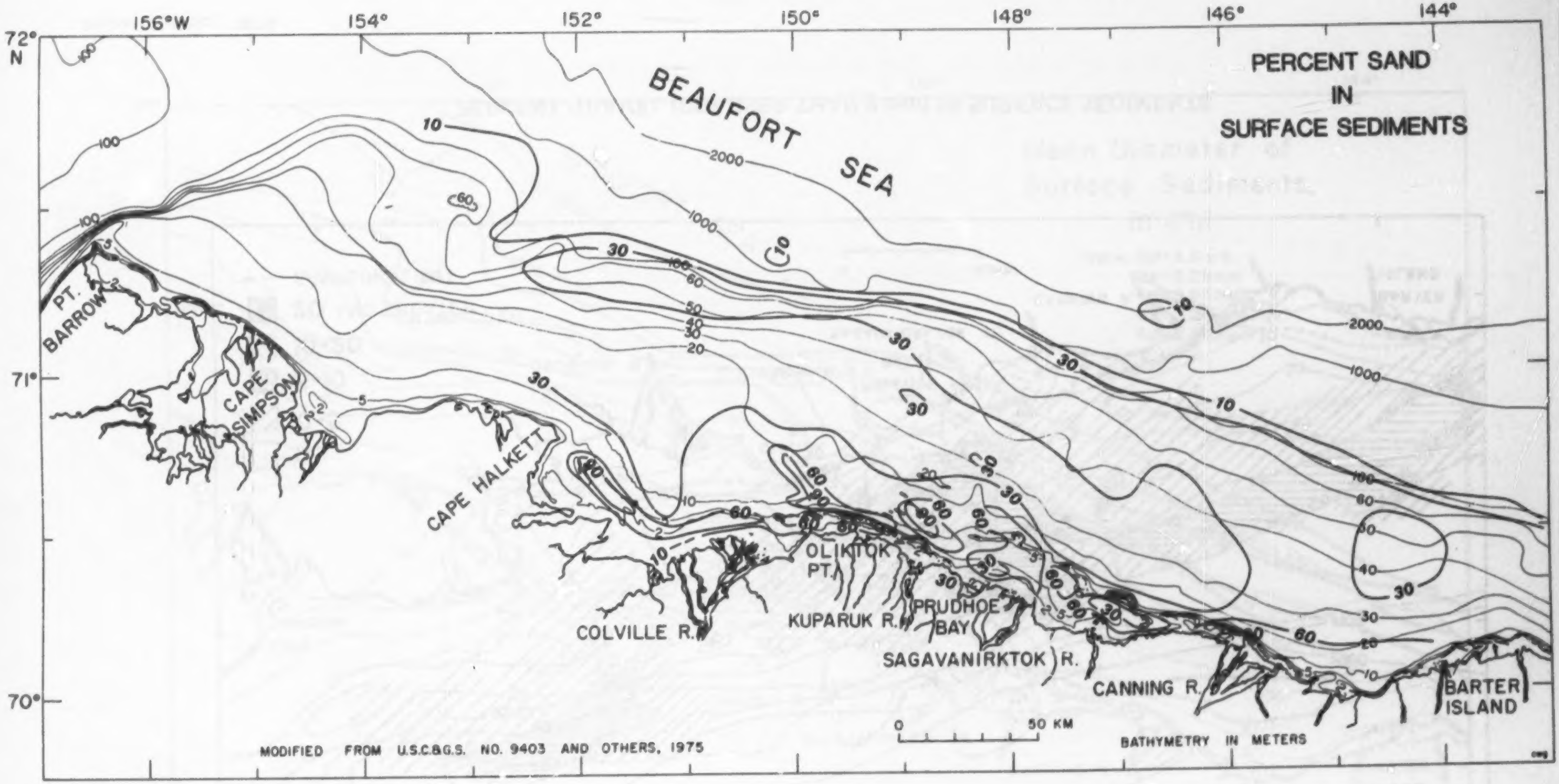
Figure III–3


PERCENT MUD
(SILT + CLAY)
IN
SURFACE SEDIMENTS
BEAUFORT SEA
72° N
71°
70°
156°W
154°
152°
150°
148°
146°
144°
2000
1000
100
90
70
60
50
40
30
20
10
5
2
PT. BARROW
CAPE SIMPSON
CAPE HALKETT
COLVILLE R.
OLIKTOK PT.
KUPARUK R.
PRUDHOE BAY
SAGAVANIRKTOK R.
CANNING R.
BARTER ISLAND
ICE
MIXED
0
50 KM
MODIFIED FROM U.S.C.&G.S. NO. 9403 AND OTHERS, 1975
BATHYMETRY IN METERS

PERCENT MUD (MEAN DIAMETER LESS THAN 0.0625 mm)

Source: Briggs, 1982.

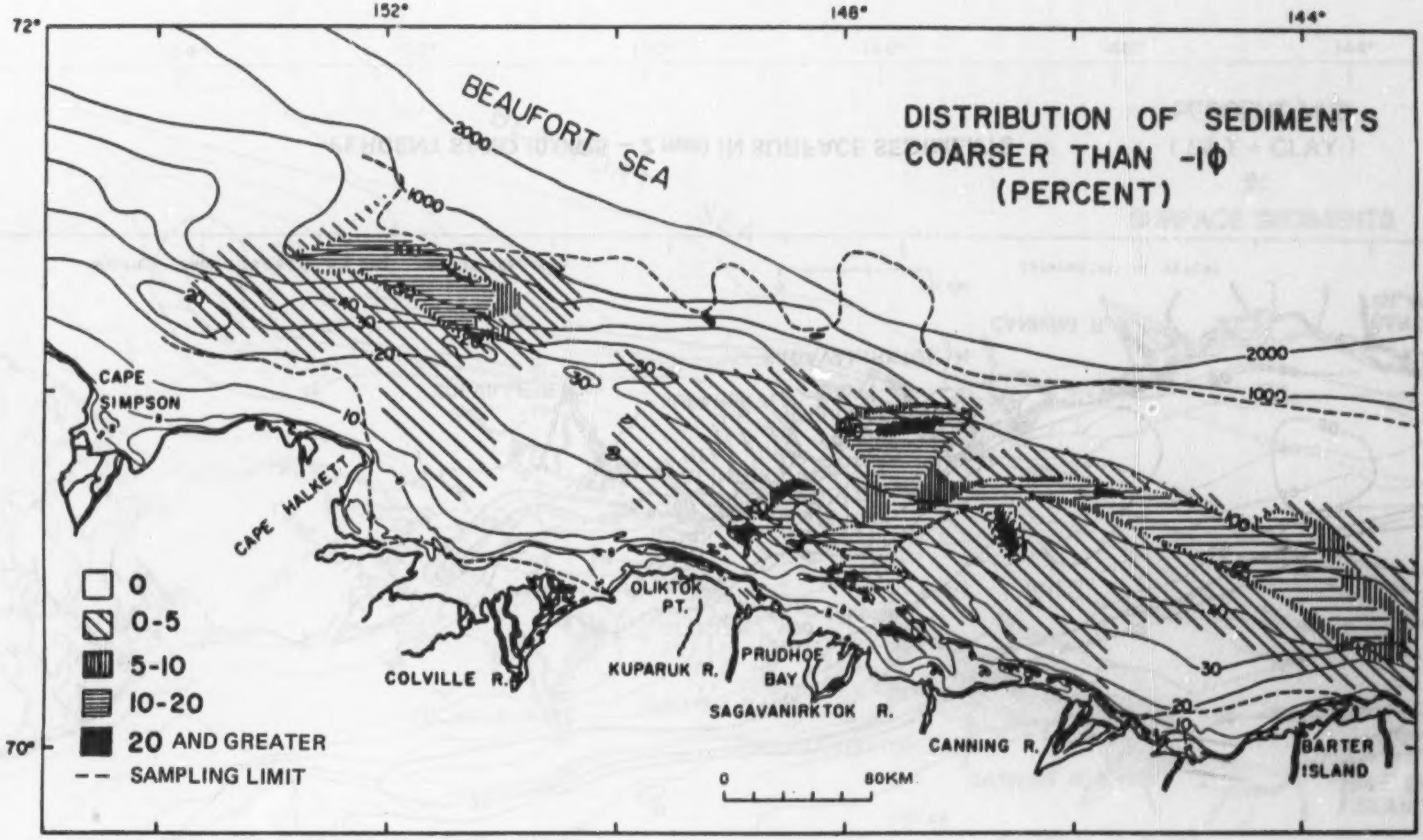
Figure III–4


PERCENT SAND
IN
SURFACE SEDIMENTS
BEAUFORT SEA
72° N
71°
70°
156°W
154°
152°
150°
148°
146°
144°
PT. BARROW
CAPE SIMPSON
CAPE HALKETT
COLVILLE R.
OLIKTOK PT.
KUPARUK R.
PRUDHOE BAY
SAGAVANIRKTOK R.
CANNING R.
BARTER ISLAND
0
50 KM
BATHYMETRY IN METERS
MODIFIED FROM U.S.C.&G.S. NO. 9403 AND OTHERS, 1975
10
30
60
90
100
1000
2000

PERCENT SAND (0.0625 – 2 mm) IN SURFACE SEDIMENTS

Source: Briggs, 1982.

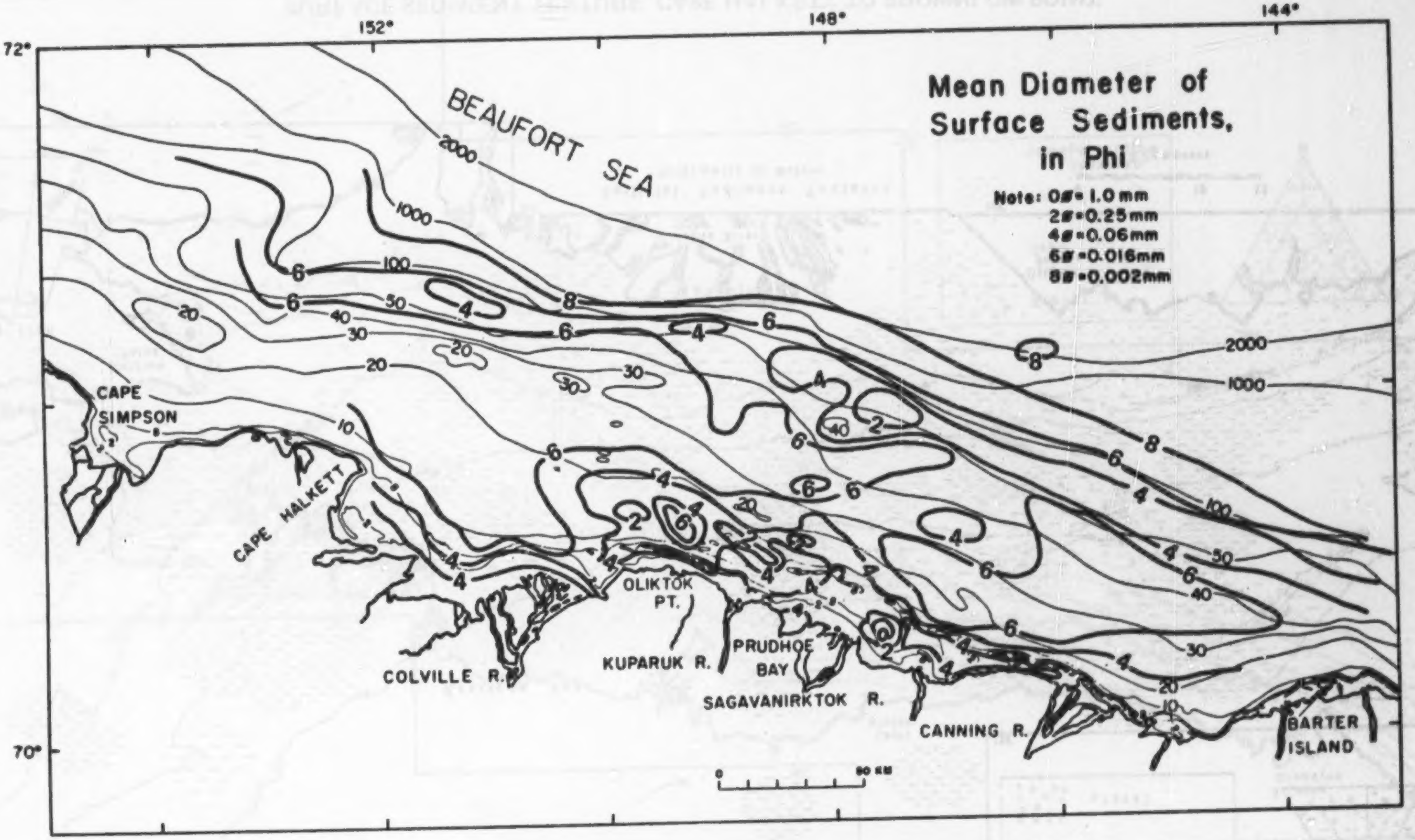
Figure III–5


DISTRIBUTION OF SEDIMENTS COARSER THAN -1ϕ (PERCENT)
BEAUFORT SEA
72°
70°
152°
148°
144°
2000
1000
CAPE SIMPSON
CAPE HALKETT
COLVILLE R.
OLIKTOK PT.
KUPARUK R.
PRUDHOE BAY
SAGAVANIRKTOK R.
CANNING R.
BARTER ISLAND
0
80KM
10
20
30
40
□ 0
▨ 0-5
5-10
10-20
■ 20 AND GREATER
-- SAMPLING LIMIT

PERCENT GRAVEL (COARSER THAN 2 mm) IN SURFACE SEDIMENTS

Source: Rodeick, 1979.

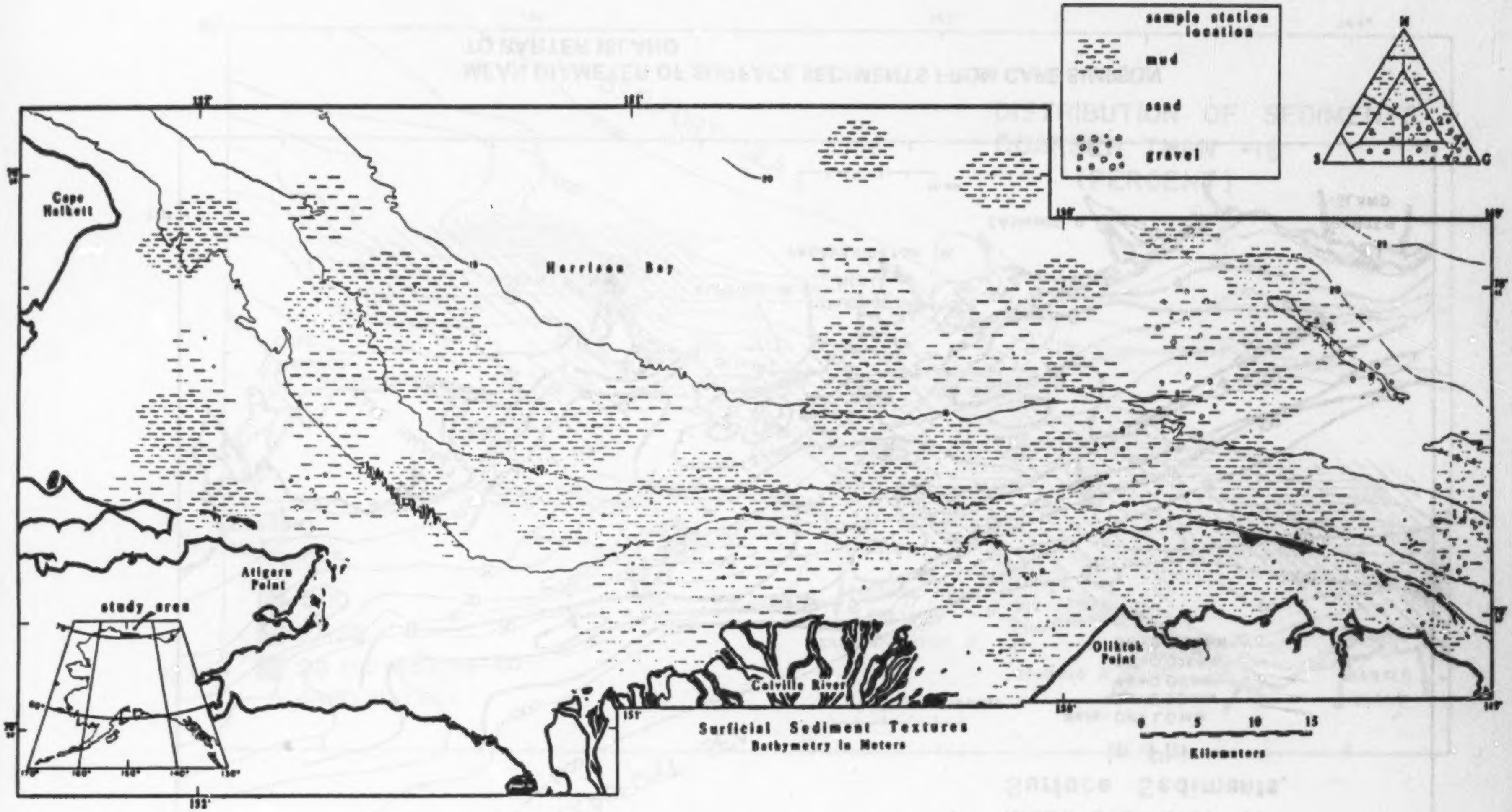
Figure III–6


Mean Diameter of Surface Sediments, in Phi
Note: 0ø = 1.0 mm
2ø = 0.25 mm
4ø = 0.06 mm
6ø = 0.016 mm
8ø = 0.002 mm
BEAUFORT SEA
72°
70°
152°
148°
144°
CAPE SIMPSON
CAPE HALKETT
COLVILLE R.
OLIKTOK PT.
KUPARUK R.
PRUDHOE BAY
SAGAVANIRKTOK R.
CANNING R.
BARTER ISLAND
0
50 KM
2000
1000
100
50
40
30
20
10
2
4
6
8

MEAN DIAMETER OF SURFACE SEDIMENTS FROM CAPE SIMPSON TO BARTER ISLAND

Source: Barnes, 1974.

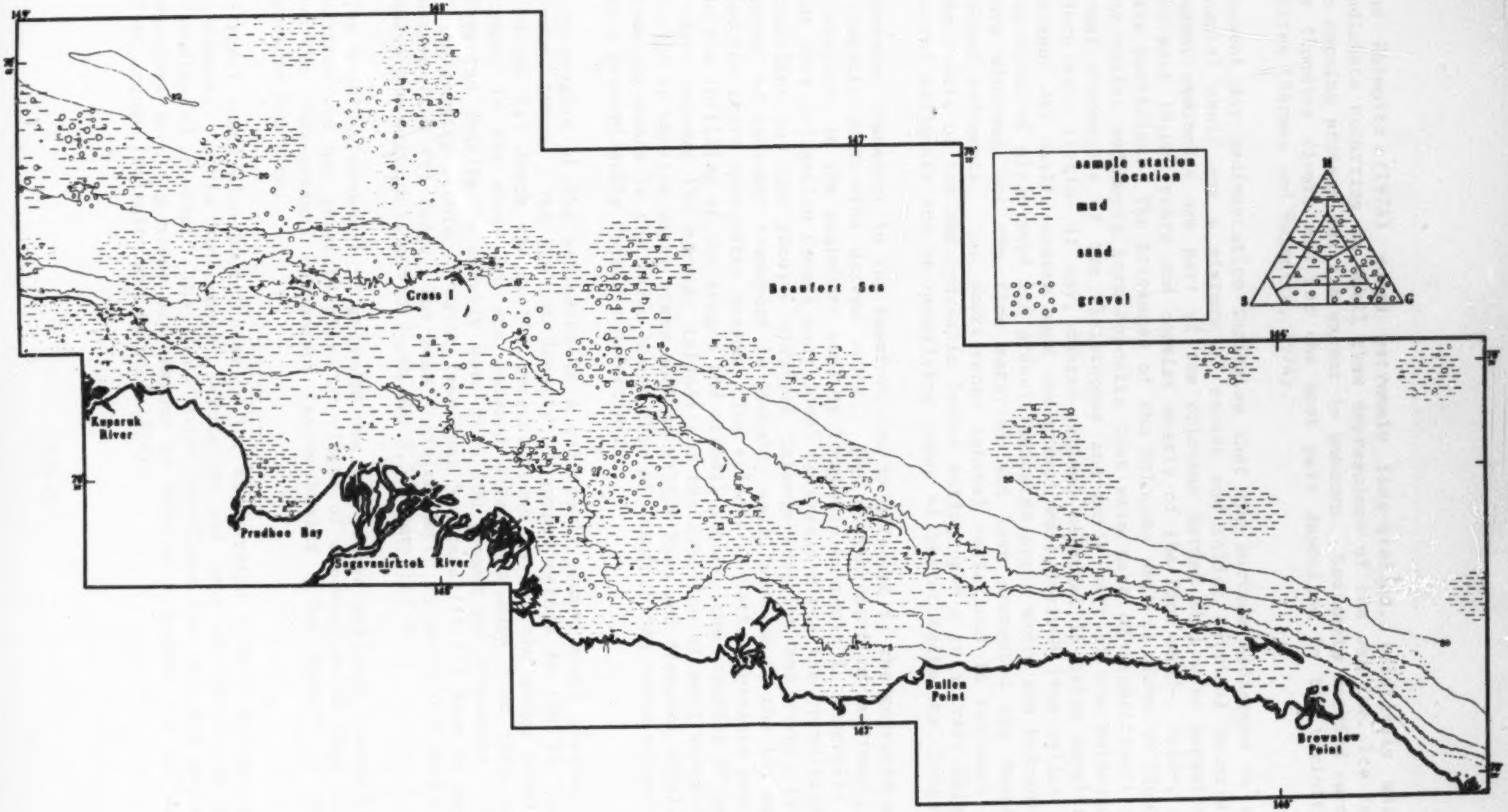
Figure III–7A


sample station location
mud
sand
gravel
M
S
G
Cape Halkett
Harrison Bay
Atigaru Point
study area
Colville River
Oliktok Point
Surficial Sediment Textures
Bathymetry in Meters
0 5 10 15
Kilometers

SURFACE SEDIMENT TEXTURE, CAPE HALKETT TO BROWNLOW POINT

Source: Barnes et al., 1980.

Figure III–7B


149°
148°
147°
146°
sample station location
mud
sand
gravel
M
S
G
Beaufort Sea
Cross I
Kuparuk River
Prudhoe Bay
Sagavanirktok River
Bullen Point
Brownlow Point
148°
147°
146°

SURFACE SEDIMENT TEXTURE, CAPE HALKETT TO BROWNLOW POINT

Source: Barnes et al., 1980.

and Reimnitz (1974) noted extremely fine-grained, relatively well-sorted sediments occurring in small thaw depressions of the sea ice. Ice rafting is an ongoing process but its extent is unknown. Sediments carried onto the ice by flooding rivers are for the most part deposited in the vicinity of the deltas (Barnes and Reimnitz, 1974).

Present day sedimentation indicates that the surface sediments on the continental shelf are a mixture of recent and relict detrital materials. The recent sediments are part of the Holocene Series that were deposited during the past 10,000 years and consist mostly of the fine sand-, silt-, and clay-size particles. The thickness of the Holocene unit is shown in Figure III-8. The relict sediments form deposits that were part of depositional and erosional processess of the Pleistocene and early part of the Holocene Epochs. Since very little, if any, coarse-grained material is being supplied to the present day shelf, coarse sand and gravel were derived from relict deposits. Exposures of clean sand and gravel indicates areas where the hydraulic forces have winnowed out the fine material and have prevented the deposition of recent sediments. The short-range lateral variations in sediment types are the result of ice and hydraulic forces acting upon a relatively thin layer of recent sediments and an underlying layer of relict sediments (Briggs, 1982).

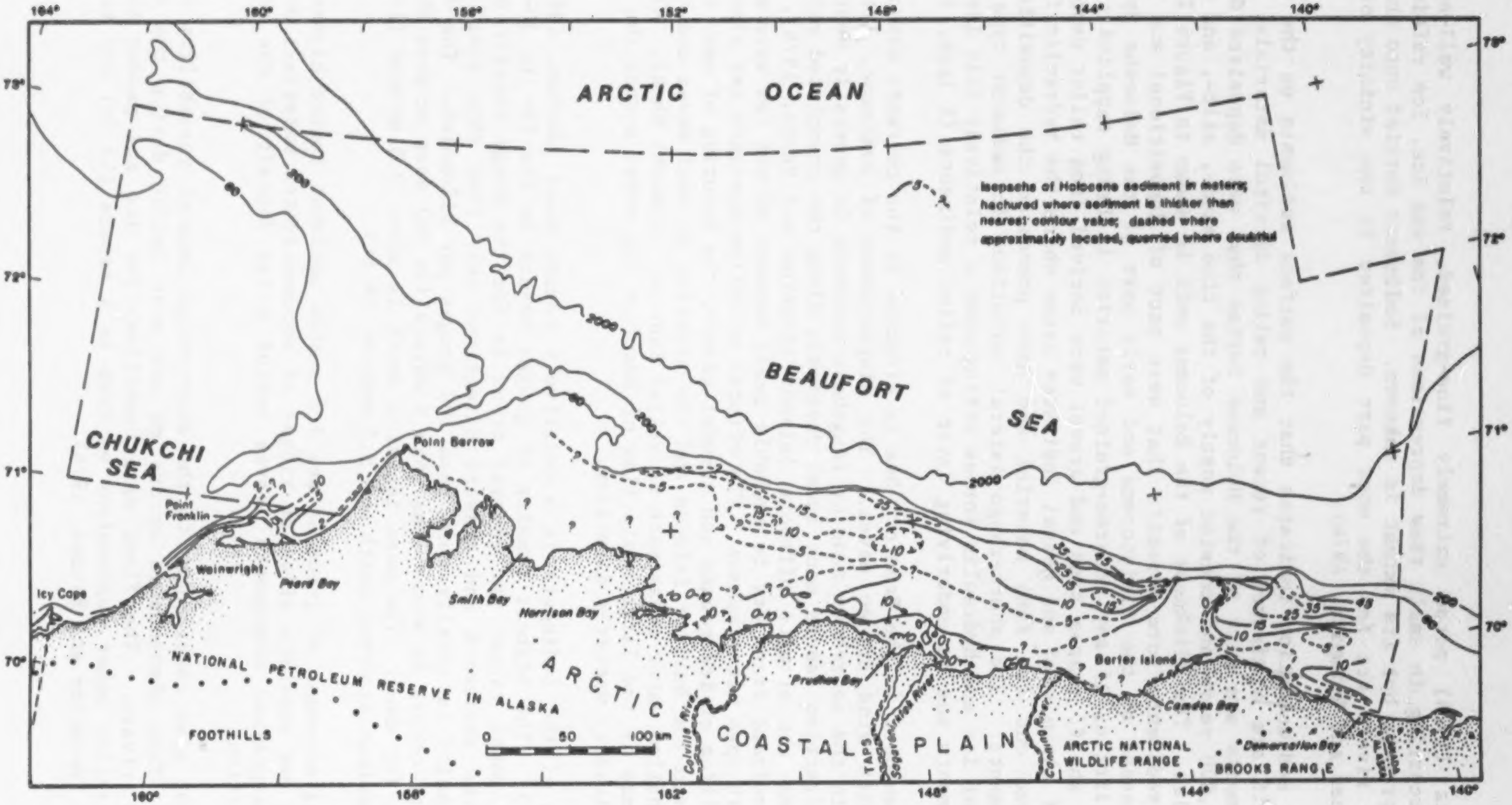
Sediment transport in the Beaufort Sea is affected by the currents associated primarily with wind driven waves. The displacement of sediment, littoral transport, in the nearshore zone by longshore currents is generally westward, but wave refraction causes many local reversals along the crenulated mainland coastline and the arcuate offshore islands (Hopkins and Hartz, 1978). The amount of sediment transport is probably small because of the low wave energy and the short open water season. The effects of bottom currents are also seen in the infilling of ice gouges and strudel scours, the scouring of many of the passes between the barrier islands and the creation of sand waves and ripple fields in shallow water areas such as Weller Bank and Stamukhi Shoal. Also of some influence is the large scale flow of Beaufort Sea water across the shelf in a predominantly westerly direction.

Ice gouging of the sediments is a relatively common event (Barnes, 1981 and Weeks, 1981). The highest density of gouges occurs in the 15- to 30-meter (50-100 ft) depth range; the general trend is for the gouge density to decrease in the shoreward and seaward directions away from this zone. The observed density is usually more than 100 gouges per kilometer. The lowest gouge density occurs in water less than 5 meters (16 ft) deep or more than 45 meters (148 ft) deep. The mean incision depth is about 0.5 meters (1.6 ft) while the maximum observed depth was 5.5 meters (18 ft).

The shoaling movement of grounded sea ice pushes sediment toward higher elevations and may generate piles or ridges of unconsolidated material; erosion of the fine-grained components leaves behind a lag deposit of the coarse-grained fraction.

Strudel scour also contributes to the short-range lateral variability of the sediments. This phenonmenon occurs on and near deltas during the spring flooding of rivers. The flood water overflows the ice and passes through openings creating scour depressions as deep as 4 meters (13 ft) and tens of feet across (Reimnitz and Barnes, 1974).

Figure III–8


164°
160°
156°
152°
148°
144°
140°
73°
72°
71°
70°
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Isopachs of Holocene sediment in meters; hachured where sediment is thicker than nearest contour value; dashed where approximately located, querried where doubtful
2000
200
60
Point Barrow
Point Franklin
Icy Cape
Wainwright
Peard Bay
Smith Bay
Harrison Bay
Prudhoe Bay
Barter Island
Camden Bay
Demarcation Bay
Colville River
TAPS
Sagavanirktok River
Canning River
NATIONAL PETROLEUM RESERVE IN ALASKA
FOOTHILLS
ARCTIC COASTAL PLAIN
ARCTIC NATIONAL WILDLIFE RANGE
BROOKS RANGE
0
50
100 km

HOLOCENE MARINE SEDIMENT THICKNESS ON THE ALASKAN BEAUFORT AND NORTHEAST CHUKCHI SHELVES.

SOURCE: Grantz et al., 1982.

Other considerations being equal, coarser-grained sediments are the preferred construction materials for artificial islands. Areas where these sediments are located include Harrison Bay, in the vicinity of the barrier islands, and on the shoals that lie seaward of these islands. Studies suggest that many of the barrier islands and shoals are constructional features and that their present morphology depends on erosional and depositional processes associated with hydraulic and ice forces and, to some extent, their origins in the geologic past.

The sand and gravel deposits of Harrison Bay (Hopkins, 1981) are (1) Pacific Shoal which stands about 1.5 meters (5 ft) above the surrounding sea floor, (2) Finger Shoal which consists of north-south oriented sand waves that are 5 feet 1.5 meters (5 ft) high and 200 meters (656 ft) wide, and (3) lying south of Finger Shoal, an unnamed shoal similar to Pacific Shoal. Finger and Pacific Shoals each contain an estimated 100,000 m^3 (130,000 yds^3) of sand. Also, in the nearshore areas, the presence of sand deposits on the deltas of the rivers between Harrison and Foggy Island Bays has been previously noted.

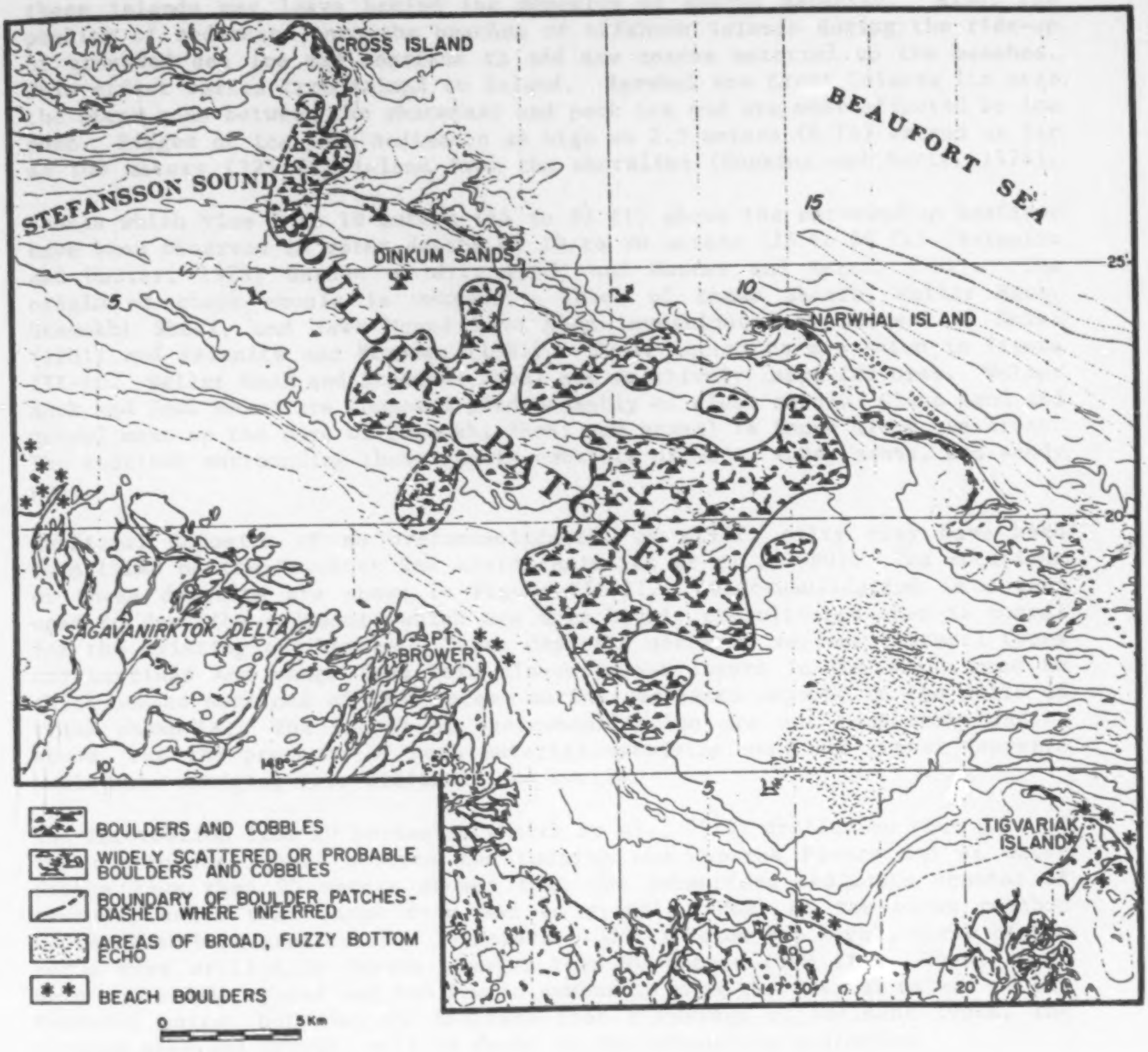
The sediments on the seafloor in the vicinity of some of the barrier islands consist of sand- and gravel-size material (Figs. III-7A and III-7B). Dinkum Sands, a shoal between Cross and Narwhal Islands, is composed of sandy and gravelly sediments. The sediments surrounding the barrier islands north of Prudhoe Bay consist mainly of clean sands (Barnes et al., 1979). On the seaward side, these sands are associated with gravels and pebbly sands but, farther offshore, the sands are associated with a stiff clay and there is no gravel.

A seafloor "Boulder Patch" is located in the western part of Stefansson Sound, (Fig. III-9, Reimnitz and Ross, (1979)). The patch is characterized by a veneer of pebbles, cobbles, and boulders up to 2 meters (6.5 ft) in diameter. The sediments in the vicinity of the Boulder Patch consist of types that range from muds through sands with some gravelly sands and patches of overconsolidated clays. The area is further characterized as being one with a low rate of deposition. The Boulder Patch is a lag deposit that was probably formed by the erosion of the Quaternary Gubic Formation deposits that were relatively rich in Flaxman Boulders. These lag deposits have also been observed on Flaxman Island and in the shallow water offshore, on the mainland east of Flaxman Island and in the nearshore waters out to a depth of 1 to 2 meters (3 to 6.5 ft), Tigvarik Island, along the delta of the Sagavanirktok River and in Camden Bay (Barnes, 1981).

Between Thetis and Spy Islands there is a well-defined shoal that contains about 10,000 m^3 (13,000 yds^3) of clean sand (Hopkins, 1981). Sand ridges 1- to 2-meters (3-6 ft) thick and 100 meters (328 ft) or more wide lie within the 10-meter (33-ft) isobath in a belt extending from Pingok Island westward past Thetis Island (Briggs, 1982). Studies by Barnes and Reimnitz (1979) and Reimnitz and others (1980) indicate that the ridges off Pingok Island are active hydraulic bedforms and that their removal would accelerate erosion of the island. However, dredging of the ridges in the western part of the belt could yield about 100,000 m^3 (130,000 yds^3) of sandy fill and would have no adverse effect.

The constructional islands of the barrier chain islands are migrating westward at rates which vary from 19 to 30 meters (60-97 ft) per year and landward from

Figure III-9


CROSS ISLAND
BEAUFORT SEA
STEFANSSON SOUND
BOULDER PATCHES
DINKUM SANDS
NARWHAL ISLAND
SAGAVANIRKTOK DELTA
PT. BROWER
TIGVARIAK ISLAND
15
10
5
5
5
25'
20'
10'
148°
50'
70°15'
40'
147°30'
20'
BOULDERS AND COBBLES
WIDELY SCATTERED OR PROBABLE BOULDERS AND COBBLES
BOUNDARY OF BOULDER PATCHES-DASHED WHERE INFERRED
AREAS OF BROAD, FUZZY BOTTOM ECHO
BEACH BOULDERS
0
5Km

LOCATION OF BOULDER PATCHES

Source: Reimnitz and Ross, 1979.

Figure III-8

3 to 7 meters (10-23 ft) per year (Hopkins and Hartz, 1978). The migration of these islands may leave behind lag deposits of coarse material. Also, the pushing of sediments onto the beaches of offshore islands during the ride-up of grounded sea ice may continue to add new coarse material to the beaches. This effect varies from island to island. Narwhal and Cross Islands lie near the shear zone between the shorefast and pack ice and are most affected by ice push. Ridges of ice push sediments as high as 2.5 meters (8 ft) extend as far as 100 meters (325 ft) inland from the shoreline (Hopkins and Hartz, 1978).

Shoals which rise 5 to 10 meters (16 to 33 ft) above the surrounding seafloor have been observed in water depths of 10 to 20 meters (33 to 66 ft) (Reimnitz and Maurer, 1978; Barnes et al., 1980; and Barnes and Reiss, 1981). The origin of these shoals is unknown. Three of these shoals, Weller Bank, Stamukhi Shoal, and Jaws Mound have been investigated by Barnes and Reiss (1981) and Reimnitz and Kempema (1981). Their locations are shown in Figure III-10. Weller Bank and Stamukhi Shoal are relatively large features. Weller Bank and Jaws Mound are composed predominantly of clean sands. Clean sand and gravel make up the core of Stamukhi Shoal and gravel is found along the crest. The seafloor surrounding these shoals consists of muds, muddy sands, and sandy muds.

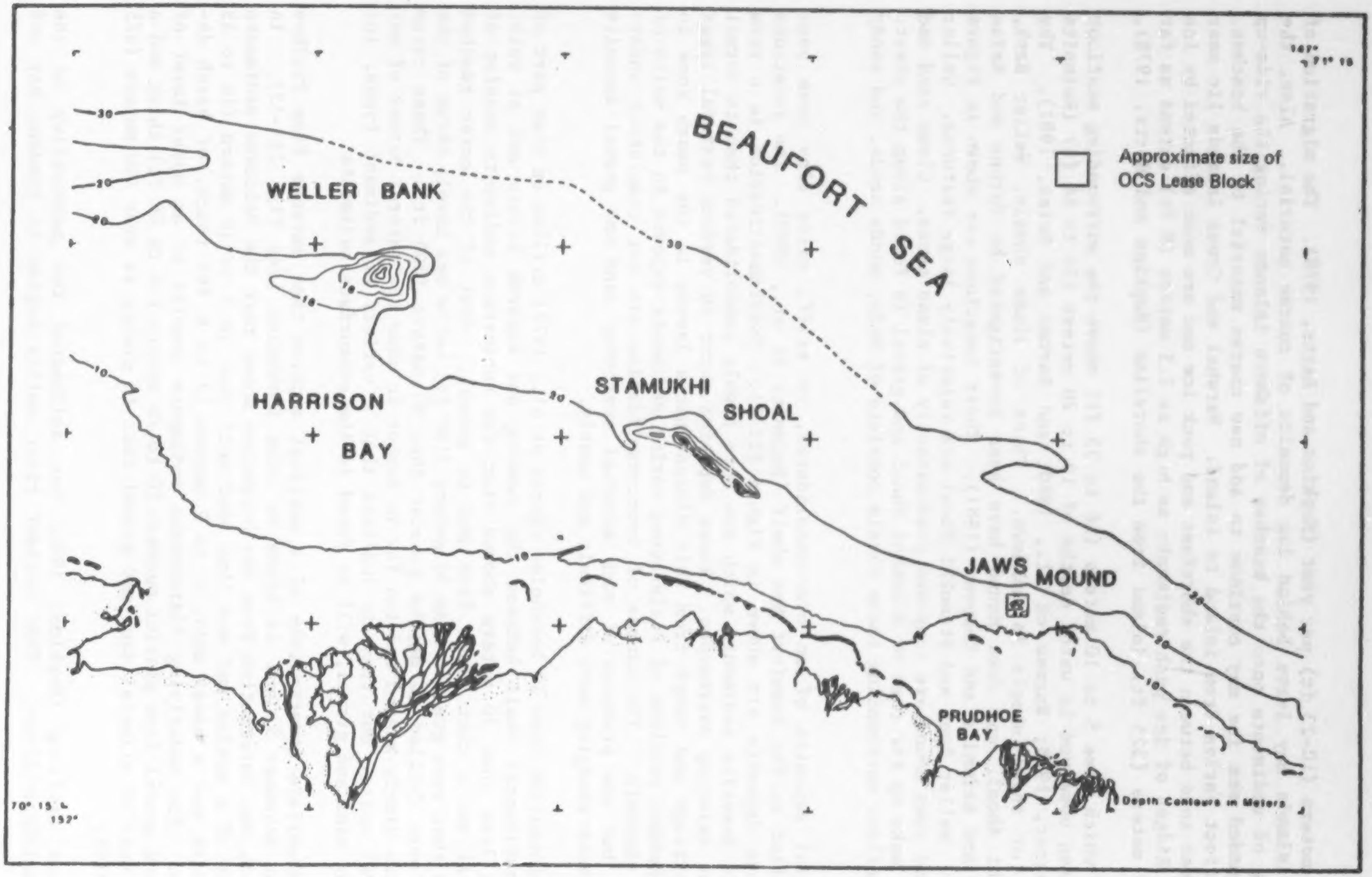
Surficial deposits of an overconsolidated, or stiff, silty clay have been identified on the Beaufort Sea shelf (Reimnitz et al., 1980). The locations of these deposits are shown in Figure III-11. Overconsolidation is a term used to describe sediments which are more highly consolidated than is normal for the existing overburden. These deposits occur in various textural types and settings and range from thin discontinuous layers in the swash zone to thick-bedded sections of Pleistocene marine sediments exposed in the walls of tidal channels. The causes of overconsolidation are not completely understood, but the presence of such material overlying sand and gravel deposits would make dredging more difficult and costly.

The information from 20 boreholes (Hartz et al., 1979) drilled on that part of the continental shelf between the Canning and Kuparuk Rivers and at water depths less than 20 meters showed that the subsurface sediments consist of textural units that range from mud to gravel. Most of the cores reached depths that were greater than 30 meters (100 ft) below sea level; three of the cores were drilled to depths greater than 90 meters (300 ft). These cores were too widely spaced and too few in number to show the lateral extent of any textural units, but they do indicate that a variety of sediment types, including sand and gravel, will be found in the subsurface sediments.

The subsurface stratigraphy of a vertical section that extends from Prudhoe Bay to Reindeer Island is based on nine boreholes (see Fig. III-12). In general, the information from the boreholes shows that the Holocene sediments consist of a marine mud and fine sand unit that is 5 to 10 meters (16 to 33 ft) thick and a basal unit, 1 to 2 meters (3 to 6 ft) thick, of beach deposits. The underlying Pleistocene sediments consist of an upper layer of sand and gravel from glacial outwash 10 to 20 meters (33 to 66 ft) thick and a lower unit of alluvial sand and gravel that in places is over 100 meters (325 ft) thick.

Offshore drilling (Hopkins, 1981) has delineated the paleovalley of the Sagavanirktok River. This ancient river valley begins in Prudhoe Bay and

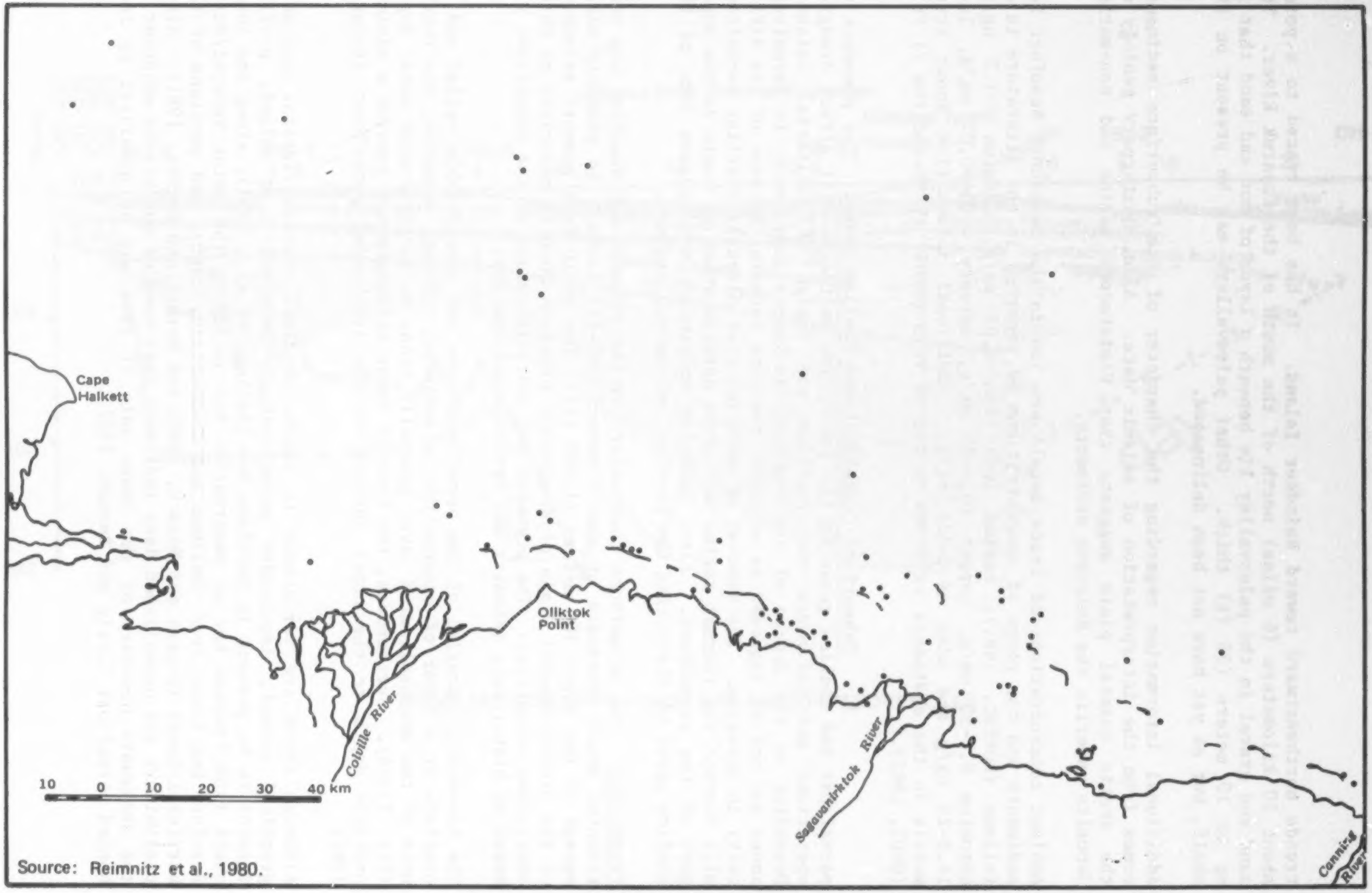
Figure III–10


BEAUFORT SEA
Approximate size of OCS Lease Block
WELLER BANK
HARRISON BAY
STAMUKHI SHOAL
JAWS MOUND
PRUDHOE BAY
Depth Contours in Meters
30
20
10
70° 15'
152°
147°
71° 15'

LOCATION MAP OF WELLER BANK, STAMUKHI SHOAL, AND JAW'S MOUND.

Source: Barnes and Reiss, 1981.

Figure III-11


Cape Halkett
Oliktok Point
Colville River
Sagavanirktok River
Canning River
10 0 10 20 30 40 km

Source: Reimnitz et al., 1980.

KNOWN LOCATIONS OF OVERCONSOLIDATED CLAY trends northwestward toward Reindeer Island. It has been traced to a point about 10 kilometers (6 miles) north of the mouth of the Kuparuk River. The sand and gravel in the paleovalley lie beneath a layer of mud and sand that is up to 10 meters (33 ft) thick. Other paleovalleys may be present on the shelf, but as yet have not been delineated.

Additional information regarding the character of the subsurface sediments comes from the interpretation of seismic data. Also, Quaternary geology of the arctic coastal plain suggests that Pleistocene marine and non-marine deposits underlie the Holocene sediments.

Ambient concentrations of trace metals are low in the nearshore Beaufort Sea sediments and the range of concentrations as reported in the literature is as follows (NORTEC, 1981); barium less than 0.05 ug/g, cadmium 1-1.2 ug/g, chromium 8.1-50 ug/g, copper 10.4-33 ug/g, mercury 0.034-0.07 ug/g, lead 14.8-29 ug/g and zinc 46.2-116 ug/g. Additional information about trace metals in the sediments is given in the BF FEIS (USDI, 1979) and the 71 FEIS (USDI, 1982).

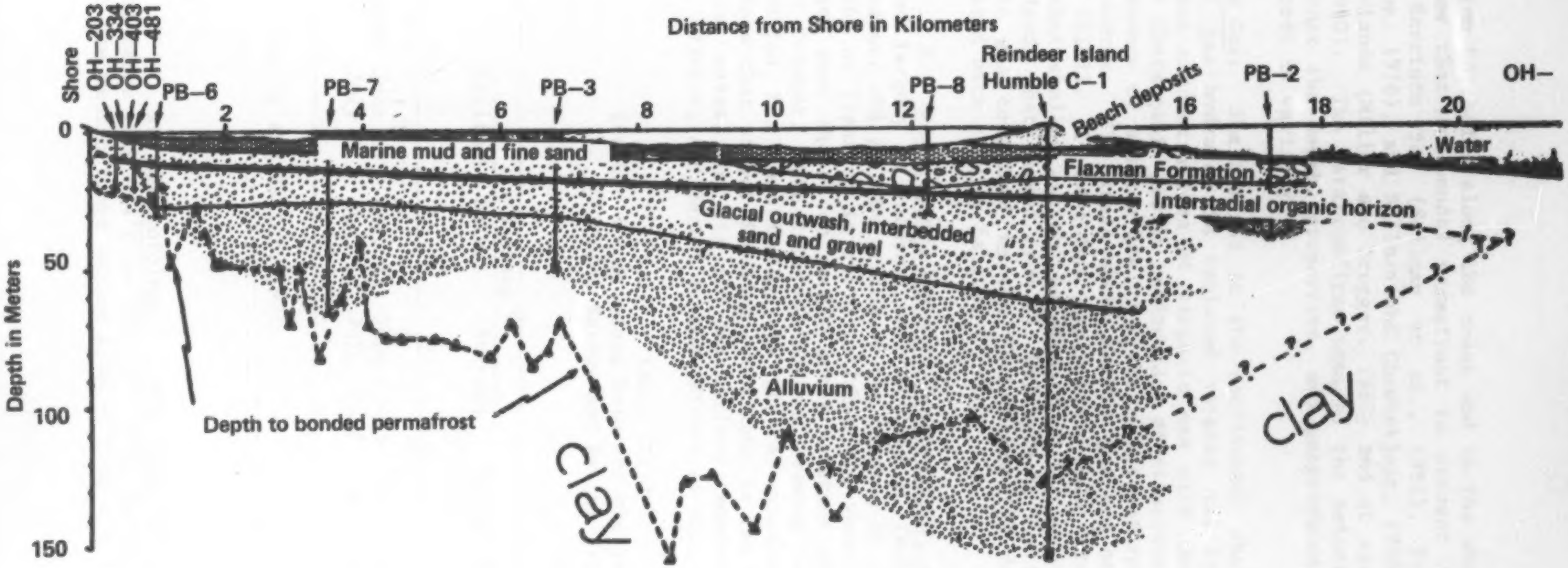
b. Subsurface Permafrost and Shallow Gases: The presence of permafrost and shallow gases in the subsurface sediments will affect dredging operations and influence the location and design of artificial islands. Depending on the degree of ice bonding, sediments that occur in permafrost zones may not be regarded as suitable resource material because of the difficulty in dredging. The removal of material that directly overlies permafrost will disrupt the thermal regime and cause deterioration to begin in the upper part of the permafrost. Also, dredging operations may release some of the shallow gases by disrupting the physical or thermal regimes.

Permafrost: The permafrost that underlies the present day Beaufort Sea continental shelf shoreward of the 90-meter (295-ft) isobath is probably widespread in the upper 500 meters (1,600 ft). The shelf is a seaward extension of the Arctic Coastal Plain physiographic province that is underlain by thick continuous permafrost. The presence and characteristics of the permafrost are based on historical, seismic, and borehole information.

The ice-bonded material of the permafrost zone has considerable relief and is overlain by a layer of unconsolidated sediment. Though variable, the thickness of the unconsolidated layer generally tends to increase with water depth (Fig. III-8). Furthermore, the base of these sediments may provide a minimum probable depth to the upper surface of the ice-bonded permafrost (Briggs, 1982).

Although there are variations in depth, physical characteristics, and geographical extent, ice-bonded permafrost is inferred from seismic profile records to be present in Harrison Bay (Sellman et al., 1981), along the inner shelf from Prudhoe Bay to Demarcation Bay including the Joint Federal/State Beaufort Sea lease area (Sellman and Chamberlain, 1980), and portions of the barrier islands (Rogers and Morack, 1980; and Morack and Rogers, 1981). Also, preliminary and unpublished data indicates that some of the blocks adjacent to the shoreward boundary of the lease sale 71 area may be underlain by ice-bonded permafrost (Craig and Barnes, 1982).

Figure III–12


Distance from Shore in Kilometers
Shore
OH–203
OH–334
OH–403
OH–481
PB–6
PB–7
PB–3
PB–8
Reindeer Island
Humble C–1
PB–2
OH–
2
4
6
8
10
12
16
18
20
Depth in Meters
0
50
100
150
Beach deposits
Water
Marine mud and fine sand
Flaxman Formation
Interstadial organic horizon
Glacial outwash, interbedded sand and gravel
Alluvium
Depth to bonded permafrost
clay
clay

CROSS SECTION OF PRUDHOE BAY BASED ON BOREHOLES

Source: Hopkins, 1979

trends northeastward toward Reindeer Island. It has been traced to a point about 13 kilometers (8 miles) north of the mouth of the [illegible] River. The sand and gravel in the paleovalley lie beneath a layer of mud and sand that is up to 10 meters (30 ft) thick. Other paleovalleys may be present on the shelf, but as yet have not been delineated.

Additional information regarding the character of subsurface sediments comes from the interpretation of seismic data. [illegible] geology of the arctic coastal plain suggests that [illegible] non-marine deposits underlie the Holocene sediments.

Ambient concentrations of trace metals in the [illegible] Beaufort Sea sediments and the range of concentration [illegible] summarized by Feldman (1977). [illegible] (1982, 1983).

[illegible] The presence of permafrost [illegible]

[illegible]

The [illegible] of the [illegible] consists of a layer of [illegible] (1983).

Although [illegible]

Data from boreholes along the coast and in the shallow parts of the Beaufort Sea show that ice-bonded permafrost is present in Elson Lagoon (Lewellen, 1973, Harrison Bay (Sellman et al., 1981), Prudhoe Bay (Osterkamp and Harrison, 1976), and Sellman and Chamberlain, 1980), in portions of the barrier islands (Miller and Brugger, 1980) and at various other sites (Smith et al., 1980). The data confirms some of the seismic interpretations and also shows that the depth, properties, and geographical extent of the ice-bonded permafrost is variable.

Shallow Gas: Shallow gas in the continental shelf sediments occurs as (1) natural gas hydrates in isolated pockets and beneath the permafrost, (2) scattered concentrations of biogenic gas with the unconsolidated sediments, and (3) thermogenic gas in sedimentary or structural traps adjacent to faults. The presence of shallow gas is based on the interpretation of seismic reflection records. The areas where shallow gas may be concentrated are shown in Figure III-13. In addition, preliminary data (Craig and Barnes, 1982) indicates that shallow gas may be present in the sediments in an area seaward of the islands that extend from Pt. McIntyre to Thetis Island. This gas may be biogenic gas contained in the Pleistocene (?) deposits or thermogenic gas associated with gravity faults.

2. Meteorology, Physical Oceanography, and Sea Ice: (This section is based largely on information contained in Technical Paper No. 7, Roberts and Tremont, 1982). The timing of the breakup of the Beaufort Sea ice and the beginning of freezeup is quite variable (as shown in Table III-2); but in an "average" year these two events occur sometime about mid-July and the first part of October. The interval between breakup and freezeup is used as the time period for considering the general oceanographic and meteorological conditions that affect dredging operations in the Beaufort Sea. Observations of winds, waves, and air and sea surface temperatures were made at Barrow, Lonely, Oliktok, and Barter Island (Brower et al., 1977).

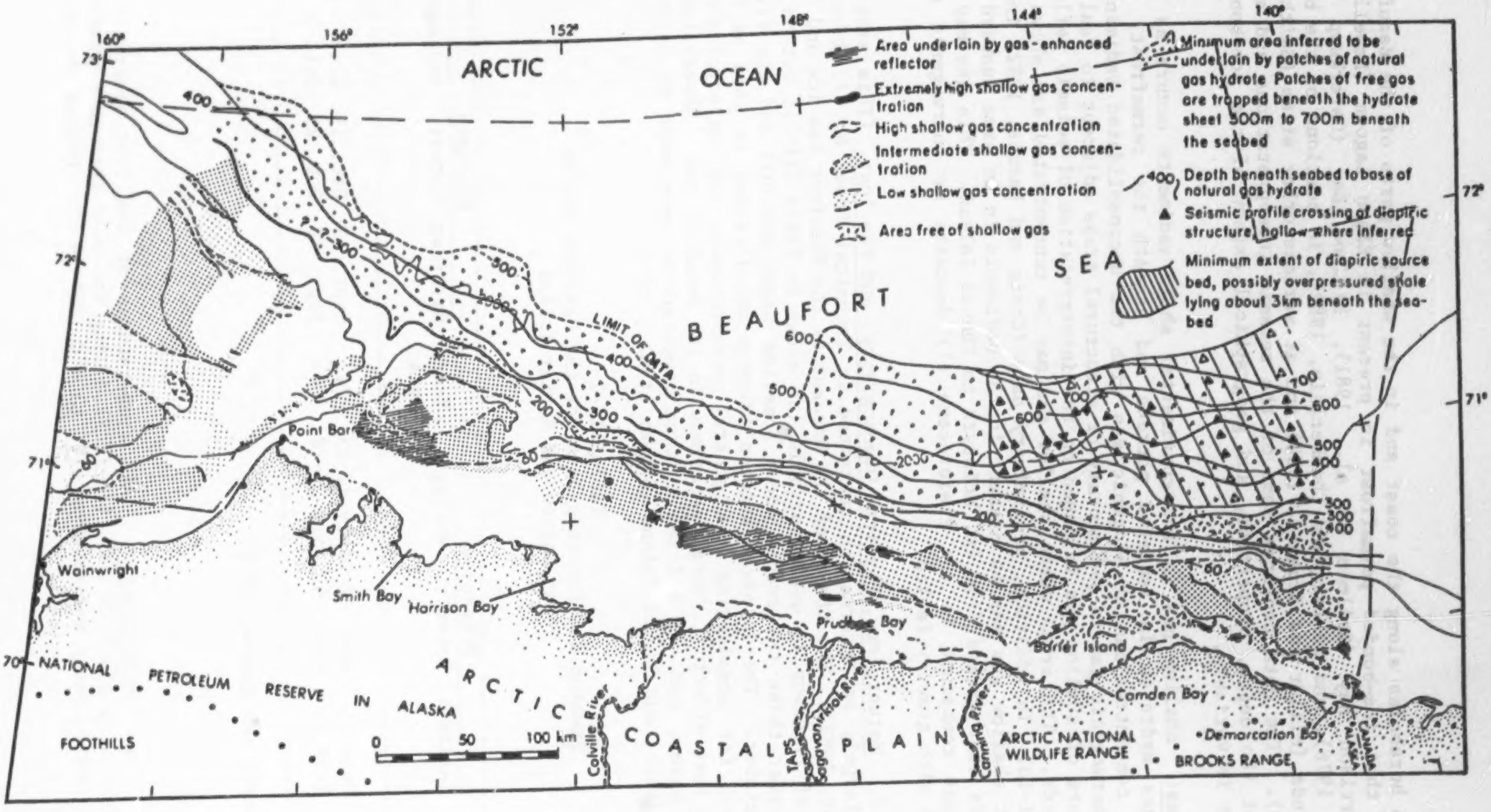
Table III-2
Breakup and Freezeup Data for the Beaufort Sea at
Point Barrow and Barter Island

	Breakup				Freezeup			
	Earliest	Latest	Average	Years Data	Earliest	Latest	Average	Years Data
Pt. Barrow	June 15	Aug. 22	July 17-23	24	Sept. 3	Dec. 19	Oct. 1-9	26
Barter I.	July 22	Aug. 4	July 7-28	4	Sept. 20	Oct. 25	Oct. 5	6

Source: Searby and Hunter, 1971.

a. Meteorology: Air temperatures of the four observation stations range from -14°C to 23°C (7°-73°F) during the July through September period; the median range varies from -1°C to 4°C (30°-39°F). During the July

Figure III–13


160°
156°
152°
148°
144°
140°
73°
72°
71°
70°
ARCTIC
OCEAN
BEAUFORT
SEA
Area underlain by gas-enhanced reflector
Extremely high shallow gas concentration
High shallow gas concentration
Intermediate shallow gas concentration
Low shallow gas concentration
Area free of shallow gas
Minimum area inferred to be underlain by patches of natural gas hydrate Patches of free gas are trapped beneath the hydrate sheet 300m to 700m beneath the seabed
400 Depth beneath seabed to base of natural gas hydrate
▲ Seismic profile crossing of diapiric structure, hollow where inferred
Minimum extent of diapiric source bed, possibly overpressured shale lying about 3km beneath the seabed
LIMIT OF DATA
400
300
200
600
500
700
60
Wainwright
Point Barrow
Smith Bay
Harrison Bay
Prudhoe Bay
Barter Island
Camden Bay
Demarcation Bay
Colville River
TAPS
Sagavanirktok River
Canning River
CANADA
ALASKA
NATIONAL PETROLEUM RESERVE IN ALASKA
ARCTIC COASTAL PLAIN
ARCTIC NATIONAL WILDLIFE RANGE
FOOTHILLS
BROOKS RANGE
0
50
100 km

AREAS OF SHALLOW GAS

through September period, direction and velocity observations indicate that (1) the winds come from the east to northeast about 50 percent of the time, (2) westerly winds occur about 18 percent of the time, (3) the wind velocity is usually in the 7- to 17-knot range, and (4) winds greater than 28 knots occur less than 5 percent of the time.

3. Physical Oceanography. During the open water period, the [illegible]

through September period, direction and velocity observations indicate that (1) the winds come from the east or northeast about 50 percent of the time, (2) westerly winds occur about 12 percent of the time, (3) the wind velocity is usually in the 7- to 17-knot range, and (4) winds greater than 28 knots occur less than 1 percent of the time.

b. Physical Oceanography: During the open water period, the circulation of Beaufort Sea water over the open shelf and in embayments and lagoons is strongly wind-driven (Aagard, 1978). The water generally flows toward the west in response to the prevailing easterlies. The circulation also appears to respond relatively rapidly to changes in the wind direction such that when the wind shifts to the west, the water flows to the east. Currents and sea ice movements are controlled by the local wind regime (Barnes and Reimnitz, 1974). The current regime is, however, modified by bathymetry and the velocities are generally low. Current meter records from inside the 10-meter (33 ft) isobath show velocities up to 25 cm/sec (0.5 knots). However, sediment bedforms, such as sand waves and ripples, indicate that currents may attain velocities on the order of 1 meter/sec (2 knots) (Barnes, 1981).

Large gradients and variability of sea water temperature and salinity are common in embayments and lagoons (Aagaard, 1978). During the open-water period, the sea surface temperatures range from -2°C (28°F) to the 12-13°C (mid-50°F). The higher temperatures occur in the nearshore waters that are influenced by the influx of the warmer water from streams and rivers. In general, the temperature of the sea surface decreases in a seaward direction.

Harrison Bay is the largest open-water embayment along the Alaskan Beaufort Sea coast. The size of the bay provides a greater fetch for westerly winds which leads to larger wind wave heights and wind-induced water disturbances (Kozo, 1981). One result of these disturbances is an increase in turbidity due to resuspension of bottom sediments. A prolonged westerly storm during the open-water period pushes more sea water toward the shore, trapping fresh water, and may also drive ice floes into the bay. The fresh water discharged by the Colville River into the eastern part of Harrison Bay creates a stratified water mass consisting of relatively fresh water overlying the more saline sea water. This stratification is disrupted by storms and mixing of the two layers occurs.

Simpson Lagoon is one of the semi-enclosed lagoons along the Alaska Arctic Coast. It extends from Harrison Bay to Prudhoe Bay, a distance of about 50 kilometers (38 miles) and is bounded on the north by the barrier islands that extend from Spy Island to Stump Island. The water of the lagoon is affected by the inflow of fresh water from the Colville, Kuparuk, and Sagavanirtok Rivers. The most dramatic effect occurs during the short period of peak river discharge in late May and early June. The river discharge floods the ice and deposits large amounts of detritus in the lagoon.

Wind-generated waves are usually small because of the restricted fetch caused by the presence of offshore pack ice. Waves with heights less than 0.5 meters (1.5 ft) and periods less than 6 seconds are the most frequently observed; wave heights greater than 3 meters (10 ft) were observed less than 1 percent of the time (Brower et al., 1977). However, the potential for generating larger waves occurs near the end of the open-water season when the fetch between the coast and the pack ice is the greatest. Major storm surges are generated by winds blowing from the west. The worst recorded storm surge in the Beaufort Sea occurred in September 1970 when the surge and wave heights were each about 3 meters (10 ft).

A storm surge is an increase or a decrease in the level of the sea above or below its mean level, and it is associated with storm systems. These systems are generated most frequently near the Aleutian Chain and pass through the Bering Strait (Matthews, 1981). Storm systems may also originate on the Siberian Shelf and then move eastward into the Beaufort Sea. In the Beaufort Sea, the storms generally progress toward the east along tracks that usually lie north of the coast. The greatest increase in sea level occurs in September and October when long stretches of open water increase the fetch and result in larger waves along the coast. Observations of strandlines along the coast tend to confirm extreme surge values of 1 to 3 meters (3-10 ft). The astronomical tidal range is very small, 10 to 30 centimeters (4-12 in) and the currents are weak.

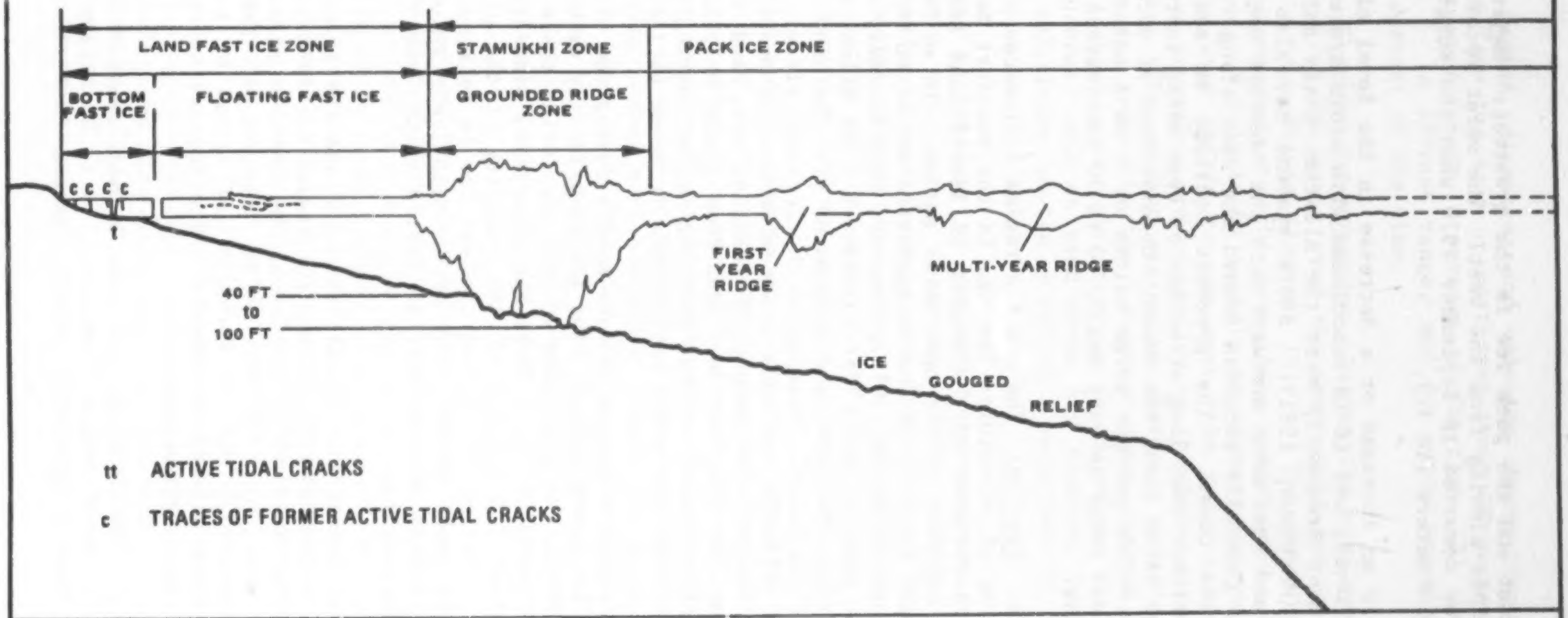
c. Sea Ice: The sea ice regime influences planning operations and the designing of structures for use in the Beaufort Sea. Marine operations that are associated with dredging of leased sand and gravel resources will be mostly confined to the open-water season. In an "average year," the edge of the summer arctic pack ice is approximately 48 to 64 kilometers (30 to 40 miles) offshore (Selkregg, 1975); however, this boundary may occur anywhere within a region that is about 257 kilometers (160 miles) wide. During the summer, winds from the east and northeast are the most common along the Alaskan Beaufort Sea coast. Because of the Corioles effect, these winds drive most of the ice offshore; westerly winds move the ice onshore. The timing of the open-water season, the amount of residual ice, and the threat of ice incursion varies from year to year and from place to place. The hulls of vessels can be strengthened so that they can operate during the latter part of the breakup period and the early part of the freezeup period.

Sea ice in the nearshore region is more mobile during the breakup and freezeup periods than it is during winter. The ice is primarily driven by winds and by ocean current forces. Displacement of the ice during these periods may be up to several miles per day. As a first approximation, wind-driven sea ice moves at a rate of about 2.5 percent of the velocity of the wind (Pritchard and Stringer, 1981). During the spring the sea ice is relatively weaker than it is in the winter, and in the fall it is relatively thinner. Large-scale movement of ice sheets in the fall and early winter can create pileups and possibly override beaches.

Based on observations of the dynamic behavior and the location of the structural types of sea ice, the winter sea ice regime of the southern Beaufort Sea may be divided into the landfast ice zone, the shear or stamukhi zone, and the pack ice zone (see Fig. III-14). The location of these zones, varies spatially and temporally and is strongly influenced by bathymetry and the position of offshore islands and shoals. The boundaries between these zones are for the most part, gradational.

Landfast Ice Zone: The landfast ice zone extends seaward from the shore out to where the water depth ranges from about 13 to 30 meters (40-100 ft). By late winter the ice is generally about 2-meters (6-7 ft) thick, relatively

Figure III–14


LAND FAST ICE ZONE
STAMUKHI ZONE
PACK ICE ZONE
BOTTOM FAST ICE
FLOATING FAST ICE
GROUNDED RIDGE ZONE
c c c c
t
40 FT
to
100 FT
FIRST YEAR RIDGE
MULTI-YEAR RIDGE
ICE
GOUGED
RELIEF
tt ACTIVE TIDAL CRACKS
c TRACES OF FORMER ACTIVE TIDAL CRACKS

WINTER ICE ZONATION OF THE BEAUFORT SEA COAST

Source: Interim Synthesis: Beaufort/Chukchi, 1978.

stable and undeformed, and out to a depth of about 2 meters (6 ft) frozen to the bottom (bottom-fast ice). The remaining ice in the landfast zone is floating (floating-fast ice). Movement of the floating-fast ice is usually on the order of tens of feet per day, but larger movements up to several hundred feet have been observed.

Shear Ice Zone: Seaward of the landfast ice zone is the shear, or stamukhi, zone. This is a region of dynamic interaction between the relatively stable ice of the landfast zone and the mobile ice of the pack-ice zone. The types of sea ice found in the shear zone consist of interspersed pressure on shear ridges, floes of first and multiyear ice, and ice island fragments. These ridges are formed by the compressional and shearing forces of moving ice impacting the more stable landfast ice. Floating first-year ridges have a ratio of sail height to keel depth that ranges from 1:3 to 1:9; multiyear ridges with sail heights up to 10 meters (33 ft) have been observed.

Pack-Ice Zone: The pack-ice zone is seaward of the shear zone and consists of (1) first-year ice, (2) multiyear floes with embeddened pressure ridges and rubble fields, (3) ice islands--very large thick masses of ice calved from Ellsmere Island, and (4) multiyear floes which may be 3 to 4 meters (10-14 ft) thick. During the winter, movement in the pack-ice zone is generally small and tends to occur in discrete events that are associated with strong winds of several days duration. The long-term direction of ice movement is from east to west in response to the Beaufort Gyral; however, there may be short-term perturbations from the general trend due to movement of low and high pressure systems across the arctic.

B. Summary of Recent Trends in Inupiat Social Systems

The following summary draws on the extensive information utilized for the most recent EIS for the North Slope region, the 71 FEIS (USDI, 1982; Secs. III.B. and IV.B.1., and the social systems impact sections for each alternative). For a more extensive discussion see also the following key references: Kruse et al., 1981; Kruse and Kleinfeld, 1981; McBeath and Morehouse, 1981; McBeath, 1982; and Worl Associates, 1981.

The economy and society of the North Slope region is in a transitional period. Subsistence hunting, fishing, and gathering activities; ceremonies, beliefs, and practices coexist with bureaucratic careers, jobs in construction and trade, or employment on the growing oilfields stretching out from Prudhoe Bay. Increasing intervillage travel, massive growth of Borough and local corporate institutions, and a growing regional identity characterize the period of the 1970's and early 1980's on the North Slope.

These changes and responses to change coexist with and are superimposed on a subsistence economy and society which is centuries old and which still integrates and organizes social behavior between Inupiat residents of the North Slope. Most residents of the villages of Barrow, Nuiqsut, and Kaktovik are still active subsistence hunters. During the mid- to late 1970's the Inupiat people suffered severe reductions in their two primary or premier subsistence resources: the bowhead whale and caribou. The crises and associated political controversy surrounding restriction and quotas on these species have focused national attention on the Inupiat subsistence lifestyle, fish and game management of these resources, and potential threats to these resources and their habitats from continued oil and gas development along the Beaufort Sea coast. Inupiat determination to maintain their cultural traditions in the face of world-wide pressure to eliminate their exemption to hunt bowhead whales is symbolic of a more generalized Inupiat resolve. Annual Inuit (Alaskan, Greenland, and Canadian Inupiat) Circumpolar Conferences, a North Slope Borough (NSB) sponsored Whale Conference, litigation, and lobbying have led to a cooperative agreement between the National Marine Fisheries Service (NMFS), NSB, and the Alaska Eskimo Whaling Commission (AEWC), concerning management of the subsistence harvests under the quota system imposed by the International Whaling Commission. The NSB coastal management program highlights the importance of whaling and other marine subsistence activities to the cultural survival of the Inupiat people, and advances are being made in Congress to provide for additional funding for arctic research.

Contemporary subsistence systems on the North Slope are composed of economic, social, and cultural activities. Modern subsistence activities require cash, and involve patterns of behavior including cooperation, mutual aid, and sharing which are at the center of traditional Inupiat culture. The essence of the contemporary Barrow Inupiat culture is evident in whaling. Whaling is governed by patterns of cooperation and an elaborate structure of sharin and distributing which serves to integrate the community socially and culturally. Whaling captains (Umeliks) and their crews form a significant social group within Inupiat society which includes virtually the whole community at one time or another during the whaling season. Whaling activities begin with the hunting of ugruk (bearded seal) in March, or earlier, and preparation of the skin boat for the upcoming season. Other whaling activities include constructing, expanding, or renovating ice cellars; repairing or building ice sleds for carrying the muktuk; preparing the trail for the whaling crews; serving on whaling crews or helping to land the whale; butchering or distributing the meat; and preparing for feasts associated with a successful hunt (Nulukutuk, or the Blanket Toss).

The significance of subsistence is not in food gathering alone but in the interweaving of food gathering, nutritional dependence on the whale and other subsistence resources, and the social and cultural identification with a unique Inupiat lifestyle. This subsistence lifestyle gives the Inupiat a sense of pride, identity, distinction, and unity in the face of increased pressure to change, coming from both outside and inside the North Slope Region. Table III-3 summarizes species use by village for North Slope villagers. Bowhead whale, caribou, ducks and geese, freshwater and ocean fish are primary resources for virtually all Beaufort Sea villages. See also Table III-4 which lists subsistence resources obtained at fishing or hunting camps located on Beaufort Sea barrier islands.

Inupiat leaders have become increasingly sophisticated in their inter-relationships with non-Inupiat government officials, oil company personnel and other institutional representatives which in turn is reflected in the growing maturity and size of relatively new institutions on the North Slope, including NSB, the Arctic Slope Regional Corporation (ASRC), AEWC, and other village and regional organizations.

The Inupiat population resides in eight villages: Point Hope, Point Lay, Wainwright, Barrow, Atqasuk, Nuiqsut, Kaktovik, and Anaktuvuk Pass. Barrow,

Table III-3
Subsistence Resource Summary

	Beaufort Sea Villages			Other North Slope Villages			
Resource	Barrow	Nuiqsut	Kaktovik	Pt. Hope	Pt. Lay	Wainwright	Atqasuk
Bowhead Whale	1	2	1	1	NA	1	NA
Beluga Whale	2	2	2	2	1	2	NA
Seal	2	2	2	2	2	2	NA
Ugruk	1	2	2	1	2	2	NA
Walrus	2	0	0	2	2	2	NA
Polar Bear	2	2	2	2	2	2	NA
Caribou	1	1	1	1	1	1	1
Moose	2	1	2	2	2	2	2
Sheep	NA	NA	1	0	NA	NA	NA
Grizzly Bear	0	0	0	0	0	0	0
Furbearers	2	2	2	2	2	2	2
Small Mammals	2	2	2	2	2	2	2
Ducks	1	2	1	1	1	1	2
Geese	1	2	1	2	1	1	1
Ptarmigan	2	2	2	2	2	2	2
Bird Eggs	2	2	2	2	2	2	2
Freshwater Fish	1	1	1	1	1	1	2
Ocean Fish	1	1	1	1	1	1	2
Flora	2	2	2	2	2	2	2
Invertebrates	-	-	-	2	0	0	NA
Murre	-	-	-	2	NA	NA	NA
Owl	-	-	-	2	0	0	2

Source: NPR-A 105(C) Field Study 1, Native Livelihood and Dependence: A Study of Land Use Values Through Time, June, 1979.

Symbols: 1 = Primary subsistence resource
2 = Secondary subsistence resource
0 = Rarely utilized/occurring subsistence resource
NA = Resource not available
- = Not listed

Definitions:

Primary Subsistence Resource: Resources that contribute substantially to family diet and which are significant cultural elements around which Inupiat society is organized.

Secondary Subsistence Resources: Foods used to supplement, to add variety and balance to local diet but which because of size or seasonality cannot sustain families for long periods. During periods of scarcity of primary resources these resources may become critical both nutritionally and culturally.

Table III-4
Subsistence Use on Offshore Islands

TLUI No.		Type of Use	Present Use
	Thetis Island	H&P	Sealing, fishing, birding
MB-1	Sanniaruk-Spy Islands	H	
MB-2	Leavitt Island	H	
MB-3	Pinu-Pingok Island	P	Sealing, Whaling, driftwood collecting, waterfowl hunting fishing
MB-4	Bertocini Island	H	
MB-5	Nukatpiat-Bodfish Island	H	
MB-6	Cottle Island	H	
MB-7	Tapquqturaq-Long Island	H	
MB-8	Napaqsraligauraq-Reindeer Island	H	
MB-9	Argo Island	H	
MB-10	Niaquq Island	H	
MB-11	Napaqsralik-Cross Island	H&P	Base camp for whaling, sealing, trapping, fishing and birding, spring and summer (near sheer zone)
MB-12	Foggy Island	H&P	caribou hunting in summer
MB-13	Narwhal Island	H	
MB-14	Jenette Island	H	
MB-15	Karluk Island	H	
MB-16	Point Lookout on Tigvagiaq Island	H	
MB-17	Tigvagiaq Island	H&P	historic trading center, fishing camp and set net site, egg gathering, sealing, waterfowl hunting
MB-18	Pole Island-Stockton Islands	P	whaling, sealing, fishing, seal and polar bear hunting, driftwood collecting, summer fishing
MB-19	Belvedere Island-Stockton Islands	H&P	waterfowl hunting, egg collecting, and driftwood collecting
MB-20	Flaxman Island	P	whaling, waterfowl hunting and ptarmigan, snowy owl hunting, trapping, polar bear hunting in winter, caribou hunting in summer

TLUI = Traditional Land Use Inventory
H = Historic Use
P = Present Use
Source: North Slope Borough Commission on History and Culture, 1980.

Nuiqsut, and Kaktovik are the three principle villages of the Beaufort Sea coast.

According to the NSB 1980 Census, of the total 5,246 residents of predominantly Inupiat communities on the North Slope, a majority or 3,401 resided in Barrow; Pt. Hope had a population of 527; Wainwright had 425 residents; Kaktovik had a population of 195; and Nuiqsut had 257 residents. At this time, Prudhoe Bay and assorted federal and oil and gas exploration camps had a total population count of 3,988. These camp workers are not considered residents of the North Slope by the state or federal government at the present time. See also Tables III.B.2.-1 through -6 in the 71 FEIS (USDI, 1981).

Barrow, the largest traditional settlement on the North Slope, is headquarters of the NSB the AEWC and the ASRC and is a traditional whaling capital. The North Slope Borough now provides most government services in Barrow. These services include police, fire, sewer, water, electricity, health, telephone, heat, power, transportation, garbage and solid waste disposal, housing and urban renewal. The Inupiat Community of the Arctic Slope represents Barrow village concerns locally. As a regional center, Barrow's population is now more heterogeneous than other NSB villages with close to 25 percent non-Inupiat in 1980 (U.S. Bureau of the Census, 1981).

Kaktovik, on Barter Island east of Prudhoe Bay, was a traditional trading center for the nomadic Inupiat. More recently, it has been moved three times to accommodate the construction of the nearby DEW-line station. Like Barrow, most services in Kaktovik are provided by the NSB. Kaktovik's traditional government is still strong.

Nuiqsut, a new Inupiat village on the Colville River, was resettled in April 1973 by 27 families who established a tent city there. A year later, 31 prefabricated homes were airlifted by the ASRC from Barrow providing permanent homes in the Colville River delta area to families some of whom were descendents of this region's former inhabitants. The village was established primarily as a staging area for subsistence activities. Most services are provided by the NSB.

Prudhoe Bay, located on state land near the mouth of the Sagavanirktok River, is still the largest and most extensively developed base camp along the Beaufort Sea coast. The Kuparuk oilfield base camp opened in 1981 and is expected to rival Prudhoe Bay in size in years ahead. The NPR-A camp at Lonely, the DEW-line site on Barter Island, and the base camp at Cape Lisburne are additional work camps for the oil industry or federal government operations on the North Slope.

C. Biological Resources

1. Stefansson Sound Kelp Communities: A description of the Stefansson Sound Kelp Communities, officially referred to as the Boulder Patch, has been provided by Dunton et al. (1982) and Dunton and Schonberg (1980). Another description and reference is provided in the BF FEIS (USDI, 1979).

The Boulder Patch has been described as an area of cobbles and boulders with attached kelp and diverse invertebrate life. This area lies within Stefansson

Sound in 3 to 9 meters of water. This habitat feature is unusual in that such assemblages have not been found elsewhere in the entire Alaskan Beaufort Sea. Much smaller areas of boulders and cobbles with attached kelp occur southeast of Belvedere Island in the Stockton Island chain, northwest of Kangigvik Point in Western Camden Bay, and seaward of Flaxman Island (Dunton et al., 1982).

The presence and continued existence of this unique community is dependent upon the availability of hard substrates (pebbles, cobbles, and boulders) in areas with minimum sedimentation protected from ice scour by ice-floes. Currents remain strong enough to maintain Stefansson Sound as a nondepositional environment despite the seasonal influx of sediment, especially from breakup of the Sagavanirktok River. Physical disruption by deep-draft ice is minimal because of the presence of shoals and offshore barrier islands which protect the Boulder Patch from intrusion by large ice floes.

The biota of the Boulder Patch includes several species of red and brown algae including the dominant kelp, Laminaria solidungula, and a diverse assortment of invertebrates and fish. Predominant invertebrates include sponges, cnidarians, soft corals, sea anemones, bryozoans, snails, clams, and starfish. Over 100 species of arthropods (seaspiders and crustaceans) and annelid worms are also present along with four species of bottom-dwelling fish. Dunton et al. (1982) provide a more detailed description of these biota.

The importance of the algae or kelp as an energy (or food) source for consumers is under investigation. It appears that linear growth of the arctic kelp is greatest in the winter, when the turbid ice canopy prevents light penetration. The kelp must rely on stored food reserves to complete over 90 percent of its annual growth during the 9-month periods of darkness. These reserves are accumulated by photosynthetic activity during the previous summer. The total carbon contribution made by the kelp in this area is about 146 x 106 grams per year or 7 grams per square meter per year. A small percentage of this carbon is consumed directly by herbivores, with the remainder being released into the environment in dissolved or particulate form which is utilized to some extent by detrital and filter feeders.

2. Plankton, Benthic Invertebrates, and Fish Resources: The organisms that form the major ecological groups of plankton, benthic invertebrates, and fish are very diverse, both in their taxonomy and functional roles. A summary of the knowledge of these diverse groups in the Beaufort Sea has been provided by Carey et al. (1978) with supplementary information by Schell and Horner (1981), and Craig (1981). This discussion will highlight these summaries.

a. Plankton: Phytoplankton are important through the process of carbon assimilation (photosynthesis) which along with other processes provide energy to maintain the animals living in the marine ecosystem. Distribution and abundance of phytoplankton (as well as other organisms) varies by season. This variability is especially acute for the Beaufort Sea region due to the ice cover during the 8 to 9 months of winter and the accompanying seasonal extremes of light and darkness.

The annual cycle begins in the fall as diatoms and microflagellates present in the water column are incorporated into the ice as it forms. These diatoms remain viable during the winter months, with blooms possibly occurring earlier in the fall. During March, with the return of light, phytoplankton cells within the ice begin to photosynthesize and reproduce. This process accelerates through break-up with culmination in a spring phytoplankton bloom and ultimate dispersion of plankton throughout the water column.

The ice algal community is important in that it is the only source of primary production in the early spring. These algae support animals (nematodes, turbellarians, ciliates, and copepods) living in the ice, as well as under ice communities (amphipods and arctic cod). Off the mouths of major rivers (Colville, Sagavanirktok, and Canning) primary production is negligible during the period between break-up and late July due to high suspended sediment loads in the fresh surface water and ice cover.

During the summer spatial distribution of phytoplankton in the water column can be described as "patchy," with seemingly no association with differing hydrography. Most species are widespread throughout temporate, subarctic, and arctic ocean regimes.

Diatoms, especially the genus Chaetoceros, appear to be the most abundant phytoplankton in terms of numbers of species and numbers of cells (greater than 12 million cells per liter). Small flagellates may be common and may dominate at a particular location or depth. Many of the flagellates and dinoflagellates are not photosynthetic, and therefore this group contributes very little to marine productivity.

Zooplankton of the western Beaufort Sea have been grouped into four categories: (1) species which are expatriates from the Bering and Chukchi Seas; (2) species occurring throughout the Arctic Basin; (3) species characteristically found in nearshore, less saline environments; and (4) species contributing meroplanktonic life history stages to the plankton. The abundance, distribution, and diversity of these categories is primarily a reflection of hydrographic conditions resulting from the clockwise circulation of the Beaufort gyre, wind-driven upwelling, and easterly intrusion of warmer, more saline Bering Sea water. Copepod species appear to be the most abundant. Other groups include amphipods, mysids, euphausiids, chaetognaths, and fish larvae. Meroplanktonic life history stages of barnacles, polychaetes (worms), hydrozoans (hydroids), gastropods (snails), and echinoderms (starfish) are also present in abundance.

b. Benthic Invertebrates: The animals in this category, along with zooplankton, comprise the intermediate level of the food web. They feed on primary producers and detritus and are either directly or indirectly consumed by other animals in the food web. For the purposes of this discussion benthic invertebrates are classified as either infaunal (living or burrowing in the bottom sediments) or epibenthic (living on top of the sea bottom). It should be noted, however, that some of these organisms maintain both modes of living depending on life history stage. Additionally, many adult epibenthic types maintain a free-swimming capability. The distribution of benthic invertebrates is strongly correlated with habitats of particular combinations of characteristics of substrate, bottom water, and food supply; many are highly correlated with depth.

Nearshore (0-2-meter depth) infauna are characterized as poor in species, poor in biomass, and lacking diversity. This is due to the formation of solid shorefast ice throughout the winter in this shallow zone. Oligochaete worms, midge larvae, and burrowing amphipods and isopods are the predominant infaunal organisms.

Mobile epibenthic invertebrates invade nearshore areas during the open-water period from year to year. In areas such as Simpson Lagoon this organisms can be quite abundant. Amphipods, mysids, isopods, and copepods are the key epibenthic invertebrates in this zone. These organisms comprise a large part of the diets of anadromous and marine fish, and waterfowl that inhabit this region during the summer season.

The inshore (2-20 meter depth) benthos varies considerably from that of the nearshore zone. The principal organisms include polychaete worms, amphipods, isopods, bivalve molluscs, priapulids. Amphipods and isopods are the predominant epibenthos. In the inshore, biomass, and species diversity are higher than that of the nearshore and generally increase with depth. There is a minimum numerical abundance zone at the 15- to 25-meter depth which coincides with the shear zone (stamukhi zone) between landfast ice and the moving polar pack ice. Ice gouging into the sediments in this zone greatly disturbs infaunal habitat, thus limiting the number of organisms and species. Additionally, seasonal environmental stress is imposed on these invertebrate communities as a result of highly fluctuating salinities.

Intense ice gouging continues into the offshore zone (greater than 20 meters depth) limiting infaunal numbers to depths of 30 to 40 meters. These numbers (biomass, number of organisms, number of species) generally increase to the shelf break where maximum numbers exist. The principal benthic organisms of this zone are polychaetes, bivalves, brittle stars, sea cucumbers, crustaceans, and snails.

c. Fish Resources: Fish using the Beaufort Sea consist of both anadromous and marine species with occasional use by freshwater species in the extended freshwater or brackish plumes off the major river mouths. Fish use can be separated into two broad habitat categories: nearshore and offshore (or marine).

During the open-water season both anadromous and marine species use the nearshore zone extensively as both a feeding and rearing area, and as a migration corridor. Areas of highest use by anadromous species are along the mainland and island shorelines usually within 100 meters from shore. Use by marine species is more widespread with variable or patchy distribution. Over 30 species of fish use the nearshore zone. Predominant anadromous species are arctic char, arctic cisco, and least cisco. Predominant marine species are arctic cod and fourhorn sculpin.

Winter use of the nearshore involves only a few marine species occupying unfrozen pockets. The anadromous boreal smelt is known to overwinter in unfrozen areas off the mouth of the Colville River.

Offshore or marine use by marine fish species can be characterized as variable and patchy. For most of the offshore species, except perhaps arctic cod, numbers and biomass are extremely low by temperate standards. Most marine species move farther offshore during the winter period. Spawning by most marine species occurs under-ice during the winter. Arctic cod is the most abundant marine species. Other predominant types include sculpins, snailfish, saffron cod, slender eelblenny, and Canadian eelpout.

3. Marine and Coastal Birds: Several million migratory birds occur along the coast of the Beaufort Sea and the proposed lease area from May through September. The most abundant marine and coastal species include red phalarope (Phalaropus fulicarius), oldsquaw (Clangula hyemalis), glaucous gull (Larus hyperboreus), and common eider (Somateria mollissima). (For a more comprehensive description of marine and coastal birds found in the arctic refer to the 71 FEIS (USDI, 1982) and the BF FEIS (USDI, 1979).

Spring migration into the lease area occurs from mid-May to June 20 (Richardson and Johnson, 1980). Sizable numbers of oldsquaw and eiders follow offshore leads, while others follow inland and coastal routes. Fall migration in late August and September is much more focused along the coast with numerous staging concentrations of birds in the lagoons, coastal lakes, and river deltas. Birds that feed offshore, such as terns, guillemots, and gulls feed primarily on fish, particularly arctic cod. Birds that feed nearshore and in shallow waters, such as oldsquaw, eiders, and phalaropes, prey on a variety of invertebrate fauna but feed intensively on epibenthic crustaceans, especially mysids, during the post-nesting and staging period in preparation for fall migration. Important coastal feeding and staging habitats are shown in Figure III.C.3.-1 of the 71 FEIS (USDI, 1982). The Colville Delta/Thetis Island and Simpson Lagoon areas are especially important from mid-July through August as intensive feeding and molting areas for oldsquaw and phalaropes as well as important stopover and staging areas for other migratory birds during fall migration. Several of the barrier islands adjacent to the proposed lease area, particularly Thetis, Cross, and Egg Islands, are nesting sites for waterfowl and seabirds.

4. Marine Mammals: Species of marine mammals other than endangered species common to the Alaskan Beaufort Sea marine habitats within the proposed borrow leasing area include ringed seal (Phoca hispida), bearded seal (Erignathus barbatus), spotted seal (Phoca vitulina largha), polar bear (Thalarctoc maritimus), and beluga whale (Delphinapterus leucas). (For a more comprehensive description of marine mammals found in the arctic see Technical Paper No. 5 "Marine Mammals, Endangered Species, and Rare Plants Potentially Affected by Proposed Federal Lease Sales in the Northern Bering Sea and Norton Sound Vicinities" (Cowles, 1981) and the 71 FEIS (USDI, 1982).

Ringed seal, a year-round resident of the proposed lease area, is by far the most common marine mammal in the Beaufort Sea with an estimated population of 80,000 seals during the summer and 40,000 seals during the winter (Frost and Lowry, 1981). Shorefast ice and stable pack ice are the preferred breeding and pupping habitat of ringed seals during the ice cover season while high summer concentrations are often associated with ice remnants (Burns, Shapiro, and Fay, 1980). Ringed seals are opportunistic feeders, preying on a variety of benthic and pelagic invertebrates and vertebrates. Occurrence of small prey organisms in concentrations sufficient for effective feeding are of particular importance in the annual nutrition of ringed seals (Lowry, Frost, and Burns, 1980). Polar bear and bearded seal are the only other marine mammals that occur year-round within the proposed sale area and they occur in relatively low numbers during the winter months. Bearded seals occur in highest numbers during May through October when beluga whale, and spotted seal

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seasonally occur in the lease area. Unlike the ringed seal, bearded seal is primarily restricted to the pack ice and feeds on benthic and epibenthic crustaceans, and bivalve mollusks. Its major concentrations occur in the Bering and Chukchi Seas with comparatively low numbers in the Beaufort Sea. Between 5,000 to 6,000 beluga whales frequent the Beaufort Sea (Frost and Lowry, 1981). During May and June they migrate offshore of the proposed lease area in the spring lead system and migrate through the lease area in the fall (September and October). Spotted seal occur along the Colville River delta in July in local concentrations and migrate out of the Beaufort Sea in the fall as freeze-up begins. Polar bear generally occur along the coast of the Alaskan Beaufort Sea and the proposed lease area from October to March when shorefast ice enables them to travel from drifting pack ice to the beach. However, polar bears are capable of swimming several miles in open water and could be found in coastal areas as well as on the pack ice year-round.

5. Endangered Species: The Endangered Species Act of 1973, as amended, defines an endangered species as any species which is in danger of extinction throughout all or a significant portion of its range. The Act defines a threatened species as one which is likely to become endangered within the foreseeable future. There are no animal species officially listed as "threatened" or intended for listing in the proposed arctic sand and gravel lease sale area. In addition, there are no listed endangered plants in the area or in areas immediately adjacent to it.

Listed endangered species which may occur in the proposed lease sale area, as reported in the Federal Register (Vol. 44, No. 12), include the gray whale (Eschrichtius robustus) and the bowhead whale (Balaena mysticetus). These species are also protected under the Marine Mammal Protection Act of 1972, the Whale Conservation and Protection Study Act of 1976, and the International Convention for the Regulation of Whaling, 1946.

a. Gray Whale: The gray whale occurs only in the North Pacific and adjacent waters of the Arctic Ocean (Rice and Wolman, 1971). Population estimates vary between researchers. Recent counts at Unimak Island estimated a cumulative count of 14,346 gray whales migrating northbound through Unimak Pass into the Bering Sea (Hessing, 1981). Other estimates have placed their total abundance at approximately 16,500 (Reilly et al., 1980). Regardless of differences in population estimates, the species may be approaching or may have exceeded pre-exploitation levels of abundance.

The primary summer range of this species is located in the Bering Sea, Chukchi Sea, and Western Beaufort Sea (Rice and Wolman, 1971). Gray whales are benthic feeders which, like most other baleen whales, probably acquire the bulk of their nutritional needs during the summer feeding period. The Northern Bering Sea, north of St. Lawrence Island, is probably the most important feeding habitat of this population. Their summer distribution is relatively restricted and coincides with regions of high densities of benthic invertebrates (amphipods) on which they forage. By June, gray whales have penetrated the southern Chukchi Sea and later, a few may move into the Beaufort Sea.

Additional information on gray whale distribution and feeding habits can be found in recent biological assessments for both "Endangered Whales of the Arctic Region with Respect to Proposed Offshore Oil and Gas Exploration"

(Cowles, 1981) and "Endangered Whales of the Arctic Region with Respect to Hard Minerals Leasing" (Dubsky, 1982), and in the 71 FEIS (USDI, 1982).

b. Bowhead Whale: Several sources (Marquette, 1978; Braham et al., 1979; Braham et al., 1980; Naval Arctic Research Laboratory, 1980; and Fraker and Richardson, 1980) contain detailed summaries of current knowledge regarding the bowhead whale in greater detail than the review presented herein. Additional information on current knowledge of the species within the Beaufort Sea region can be located in the above-referenced biological assessments (Cowles, 1981 and Dubsky, 1982) and throughout the 71 FEIS. Reviewed here is a brief summary of population status and seasonal migration within the proposed sand and gravel lease area. The bowhead whale population has been estimated by Braham et al. (1979) to number close to 2,200 animals in the Bering Sea stocks. More recent estimates by Dronenberg et al. (1982) place the species at a low estimate of over 3,100 animals.

The northward spring migration is timed with ice breakup; usually most bowheads have entered the Chukchi Sea by early May (Braham et al., 1979). Once in the Chukchi Sea, most bowhead whales follow nearshore leads in the flaw zones from outer Kotzebue Sound to Barrow. After reaching Barrow, the bowhead whales move offshore in a northeasterly direction toward Banks Island, and the majority of whales enter the Canadian Beaufort Sea by mid-June (Fraker and Richardson, 1980; Braham and Krogman, 1977; Braham et al., 1979). In most years, it is likely that relatively large numbers of bowhead whales could be far offshore and north of the proposed lease sale area from April through late May. Usually beginning in August and September, the return or fall migration from the eastern Beaufort Sea moves along the northern Alaskan coast and through the proposed lease area in a broad front, primarily in shallow waters out to the ice-pack (Braham and Krogman, 1977; Ljungblad and Platter-Reiger, 1980). Recent observations indicate that the bulk of the population migrated westward through the Alaskan Beaufort Sea from September 27 through October 17 (Ljungblad et al., 1980). Available data suggests that when heavy ice prevails in the fall, bowheads may migrate earlier. In 1980 ice conditions were very heavy, contributing to the longer migration of September 9 to October 9 (Ljungblad et al., 1981). Thus, even though the fall-migration from Canadian waters may begin as early as mid-August and last until early November, the major part occurs in Alaskan waters during September and the first half of October (Fraker and Richardson, 1980).

D. Water Quality

The quality of the Alaska Beaufort Sea water is nearly pristine (USDI, 1979). Because there has been little or no industrial activity, most impurities occur at low levels. They are introduced into the marine environment through river runoff, coastal erosion, and natural seeps. The rivers which flow into the Beaufort Sea remain relatively unpolluted by man's activities.

The Beaufort Sea sediments do not contain the types of pollutants that may enter the water column when the rivers, harbors, or nearshore areas of industrialized and more heavily populated regions are disturbed. Hence, the matter introduced into the Beaufort Sea marine environment by dredging operations will be the naturally occurring chemical and physical constituents of the sediments and interstitial water. Also, since the concentration of trace metals in the sediments is low (Sec. III.A.1.) the major effect that dredging will have on the Beaufort Sea marine environment will be to increase the concentration of particulate matter in the water column.

1. Turbidity: Satellite imagery and suspended particulate matter data suggest that, in general, turbid waters are confined to depths within the 5-meter (16-ft) isobath and do extend seaward of the barrier islands (Naidu, 1979). Water samples obtained in August 1978 from the continental shelf between Harrison Bay and the Canning River and seaward of the 20-meter (66 ft) isobath had suspended sediment concentrations that ranged from 0.3 to 2.1 mg/l (Naidu, 1979). The water samples for these measurements were taken at the surface and at various depths; at one of the stations the water at 90 meters (295 ft) was also sampled. In mid-June through early July the shallow inshore waters generally carry more suspended material because runoff from the rivers produces very high turbidity adjacent to the river mouths. During the June flood, the Colville River discharges approximately 6 million metric tons (6.6 million short tons) of sediment into Harrison Bay; this is about 70 percent of its annual load (Arnborg et al., 1967). The resulting turbidity from the floods, along with other factors, blocks light and measurably reduces primary productivity of waters inshore of about the 13-meter (43 ft) isobath (Lowry and Frost, 1981). Wave action resulting from prevailing winds and storms during the open-water season resuspends bottom sediments which increases the turbidity in shallow lagoons and other shallow inshore areas (Schell and Horner, 1981).

In late summer, satellite photographs show that water from the Colville and Sagavanirktok Rivers is relatively clear. This suggests that the origin of the relatively highly suspended sediment levels in coastal waters in late summer is resuspension of bottom sediments derived from very shallow water (Naidu, 1979). Suspended sediment concentrations were determined for the surface waters in Simpson Lagoon in August 1978 and July through August 1979 (Naidu, 1979 and Naidu, 1980). In 1978, the concentration of suspended sediment ranged from 1 to 55 mg/l and in 1979 they ranged from 2 to 10 mg/l except at one station where 120 mg/l of suspensates were reported (1 mg/l equals approximately 0.000033 oz/qt). The content of clay-size particles in the surface sediments of Simpson Lagoon ranges from about 4 to 25 percent (Naidu, 1979). Also during the period August 13 to September 3, 1978, a time-series set of suspensate concentrations was determined for water at the surface and at the depth of 0.9 meters (3 ft) at a single site off Milne Point. The concentration ranged from 2 to 36 mg/l (Naidu, 1979). These data show that considerable variability in suspended sediment concentrations can be expected between locations and with time.

2. Dissolved Oxygen: Dissolved oxygen levels in the Beaufort Sea waters are usually high, about 8 mg/l (Hufford, 1974). During the ice-covered period when exchange with the atmosphere practically ceases, the oxygen concentration may be reduced to 6 mg/l in some areas of restricted circulation. In areas of restricted circulation, or high biological oxygen demand, the depletion can be much greater and some extremely isolated basins may become anoxic before spring breakup (Schell, 1979). For additional information, see the BF FEIS (USDI, 1979).

E. Other Issues

1. The Economy: The description of the economic factors associated

with the proposed arctic sand and gravel lease sale will be the same as discussed in Section III.D. of the 71 FEIS (USDI, 1982). An up-to-date description of the statewide economy for Alaska is provided in the "Draft Statistical and Census Division Demographics and Economic Systems, Navarin Basin (83) Impact Analysis" (ISER, 1982).

2. Coastal Zone Management: The Alaska Coastal Management Program was approved by the U.S. Department of Commerce in 1979. State coastal management policies and guidelines included in the state program are being refined by local coastal districts as they develop local coastal management programs (CMP's). Completed local programs are submitted to the Alaska Coastal Policy Council for review and approval. Upon receiving state approval, local CMP's provide the policy framework for state and local consistency determinations. The federal government must also approve the local program as an amendment to the state program or as a routine program implementation. After receiving federal approval, the local plan becomes the basis for federal consistency determinations in that district.

The North Slope Borough (NSB) has completed a draft set of coastal management policies. These policies are currently undergoing revisions. The coastal policies are expected to dovetail with the policies being developed for the Borough's land use plan. Under the present schedule for completion of that document, final policies will become available in December 1982. Although the policies will not have been adopted by the state through the coastal management process, the land use policies will provide a basis for predicting the probable coastal management policies for the Borough. The orientation of the Borough's policies is directed toward the protection of the subsistence way of life. Resource extraction and development activities are permissible to the extent that (a) mitigating measures are implemented to protect subsistence resources and local access to those resources and (b) the local economy is spurred. For a complete description of the federal and state coastal management legislation and the progress made by the North Slope Borough in completing a local coastal management program, see Section III.E.1. of the 71 FEIS (USDI, 1982).

Because the North Slope Borough coastal management program is not completed, this discussion focuses on the guidelines and policies contained in the state coastal management program. Since no onshore facilities are anticipated in conjunction with this proposal, the applicable policies are more limited. These policies address habitats, air and water quality, archaeology, subsistence uses, mining, and transportation.

As a general policy, habitats must be managed to ensure their viability in supporting living resources associated with the habitat. Offshore habitats must be regulated as a conservation zone to protect or enhance fisheries, including subsistence fisheries (6 AAC 80.130). The description of the fishery resources present in the proposed sale area is in Sections III.C.1. and 2. Subsistence use of the fisheries is emphasized in Section III.B.

Air and water quality policies in the coastal management program are identical to those of the Department of Environmental Conservation. All statutes, regulations, and procedures with respect to the protection of air, land, and water quality are incorporated by reference into the coastal management program (6 AAC 80.140). Water quality in the proposed lease sale area is discussed in Section III.A.3.

Archaeological policies are contained in one broad statement. The policy supports the identification of coastal areas important to the study understanding, or illustration of national, state, or local history or prehistory (6 AAC 80.150). The North Slope Borough has indicated a vital interest in preserving these areas. Details of the archaeological resources of the proposal are covered in Section III.E.4. of this EIS.

Especially important to the NSB are the barrier islands from Thetis Island to Icy Reef. Barrier islands and lagoons receive special attention. In these areas it is required that the physical regime be maintained so there is infilling of lagoons or erosion of barrier islands. Moreover, activities which would decrease the use of the habitat by coastal species such as polar bear and nesting birds, should be discouraged.

Subsistence use of coastal resources is given full recognition in the Alaska coastal management program. Specifically, the CMP policy states that opportunities for subsistence use of coastal resources must be assured. The policies lack specificity, however, until local programs are developed. District programs may identify areas where subsistence is a dominant use and has priority over all non-subsistence uses and activities. Mitigating measures may be required to assure continuation of the subsistence usage of the area (6 AAC 80.120). This policy forms the basis of the NSB draft coastal management plan and will remain of high value in the final CMP (Maynard and Partch, 1982). A description of the distribution and use of subsistence resources in the Borough is given in Section III.B. of this EIS.

Mining policies specifically cover sand and gravel extraction. Sand and gravel extraction is permissible from coastal waters, intertidal areas, and barrier islands if there are not feasible and prudent alternatives (6 AAC 80.110). An additional caveat in the NSB draft coastal management policies requires that shoreline dynamics remain unaltered (Maynard and Partch, 1982). In practice, the State of Alaska has attached a mitigating measure on their oil and gas leases for state sale 34 prohibiting borrow extraction from barrier islands.

Transportation policies are oriented toward land systems. The only policy especially applicable to this proposed lease sale would be that routes must be compatible with district programs (6 AAC 80.080). Although the NSB district program is not final, the content of several draft transportation policies is relevant. These policies emphasize the use of limiting transportation to specific corridors and minimizing disturbance of water courses, wetlands, and tidal marshes during the construction of airports and seaports (Maynard and Partch, 1982).

No policy guidance on the current CMP planning effort is presently available. The Borough's CMP administrator expects the policies contained in the 1979 conceptually approved plan for the Mid-Beaufort coastal zone to be substantially reproduced in the new plan (personal communication, Ms. Karla Kolash, NSB, 1981). Refer to Section V.B.3. of the Beaufort Sea SEIS (USDI, 1980) for a summary discussion of these policies.

3. Transportation Systems: Existing transportation systems on the North Slope and interior Alaska serving the North Slope are thoroughly discussed in the BF FEIS (USDI, 1979) and the 71 FEIS (USDI, 1982).

Surface Transportation: The North Slope Haul Road is the only road accessing the North Slope from interior Alaska. Thus, it provides the only road link to the state highway system.

Annual average daily vehicle traffic (AADT) on the Haul Road has been declining since 1977. This was the year when construction of the TAPS system was completed. Vehicle capacity on the Haul Road has been estimated at between 175-550 passenger car units in both directions on an AADT basis (Berger and Associates, 1980). The AADT vehicle counts in the past few years have been at or below 100 AADT.

Nearly every community and Distant Early Warning System (DEW-line) site on the North Slope has an internal, rudimentary road system linking the village or site with an airport, marine lightering site, or both. There are no public roads or highways connecting North Slope villages to one another. Winter trails connect some of the communities. These include historic trails used by village people as well as trails established during post-war oil exploration conducted by the U.S. Navy or during construction of the DEW-line stations.

The Prudhoe Bay Unit (PBU) has an extensive, high quality gravel road system linking the Deadhorse airport, the PBU facilities, the various drill pads, storage, and dump sites. The PBU gravel road system connects with the North Slope Haul Road. The main gravel roads within the PBU are referred to as the "spine road" system. The spine road system is being extended westerly to serve the Kuparuk River field development.

Marine Transportation: The arctic coast presently has no deepwater ports. Barges and lightering vessels are used to move cargo from ships anchored offshore. The villages of Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik receive barge shipments once a year from Seattle. Occasional supplemental barge service is provided to North Slope communities out of Kotzebue.

Three docks to unload barges exist at Prudhoe Bay, one at the east dock and two at the west dock. The east dock can accommodate vessel drafts of 4 feet, and the west docks can accommodate vessel drafts of 6 and 10 feet respectively. The end of the west dock has been expanded to accommodate deeper draft barges as part of the Prudhoe Bay Unit Waterflood Project.

Annual sea lift operations to Prudhoe Bay involve shallow draft barges which tie up directly to the west dock as well as deeper draft barges that require lightering. Peak years of goods movement by the marine mode have been 1970 (187,000 tons) and 1975 (153,000 tons); these years correspond with the Prudhoe Bay Unit construction and Trans-Alaska Pipeline System (TAPS) construction respectively. In comparison, 1981 sea lift traffic to Prudhoe Bay is estimated to be 70,000 tons.

Air Transportation: Numerous air facilities are present on the North Slope; however, most of these are gravel air strips without sophisticated aids to navigation. Public airports exist at the villages of Barrow, Anaktuvuk Pass, Nuiqsut, Kaktovik, Point Hope, Point Lay, Umiat, Wainwright, and at PBU facilities. Of these, only Barrow, and Deadhorse/Prudhoe Bay have paved runways and receive regularly scheduled commercial carriers. Air taxi services exist at Barrow and Kaktovik for intra-regional service. Four charter companies operate out of Deadhorse to serve the petroleum industry as well as village needs. Additionally, Sohio and ARCO oil companies have chartered their own passenger flights between Deadhorse and Anchorage.

4. Land Status and Land Use:

a. Land Status: Land tenure in the arctic is divided between areas of fixed ownership and areas in flux. Most of the land in the arctic is owned by the federal government. Of the approximately 20 million hectares (50 million acres) in the region north of 68° N. latitude, one half is in the National Petroleum Reserve in Alaska (NPR-A) in the Arctic National Wildlife Refuge (ANWR). The state of Alaska owns approximately 1.4 million hectares (3.5 million acres) of North Slope lands between the Colville and the Canning Rivers. An additional 1.4 million hectares (3.5 million acres) are owned by eight Native village corporations (Barrow, Kaktovik, Nuiqsut, Wainwright, Atkasuk, Point Lay, Point Hope, and Anaktuvuk Pass) and the Arctic Slope Regional Corporation created under the Alaska Native Claims Settlement Act, 1971.

Within the major land status classes identified above, there is further subdivision of lands for particular uses. Within the NPR-A, several Native allotment applications have been made. The State Legislature has authorized the North Slope Borough to select 36,400 hectares (90,000 acres) of vacant, unappropriated state land. Refer to Graphic No. 7 in the 71 FEIS (USDI, 1982) for a schematic depiction of land status within the North Slope Borough (NSB) boundaries.

There are seven active and ten inactive DEW-line stations along the Alaskan arctic coast. Facilities at these sites typically consist of several buildings, fuel storage tanks, a landing strip, and a few local roads. The Naval Arctic Research Laboratory (NARL) facilities, located approximately 6 kilometers (4 mi) northeast of Barrow, comprise a compound of 1,850 hectares (450 acres). NARL has been de-activated by the Department of Defense because of the expense of maintaining a research facility. However, a provision in ANILCA requires DOI, DOE, and DOD to study the feasibility of reopening NARL for purposes of basic and applied arctic research (18 U.S.C. 3147).

b. Land Use: Major land uses on the North Slope are divided between traditional subsistence uses of the land and hydrocarbon development operations. The traditional settlement patterns and subsistence uses of land are discussed in Section III.B. The extent and location of hydrocarbon exploration, development, and production operations on the North Slope and offshore areas are discussed in the 71 FEIS (USDI, 1982).

c. Land Use and Comprehensive Plans: The presence of land use or comprehensive plans in the area of this proposal can be more significant than existing land use conditions because the plans can influence and/or govern activities that occur within their jurisdiction. CEQ regulations implementing NEPA require the EIS to include discussion of "possible conflicts between the proposed action and the objectives of federal, state, and local (and in the case of reservations) land use plans, policies, and controls for the area concerned (40 CFR 1502.16[c])."

North Slope Borough Comprehensive Plan (Draft): The North Slope Borough is currently preparing a comprehensive plan for the entirety of the Borough. This plan is being prepared pursuant to state enabling authority in Title 29 of Alaska Statutes which confer upon local general purpose governments the opportunity to prepare comprehensive plans, and implement ordinances. Presently, the Borough intends to coordinate its present comprehensive planning effort with its District Coastal Management Program. The Borough hopes that parallel development and adoption of the two plans will yield a more cohesive and effective program (personal communication, Ms. Shehla Anjum, North Slope Borough, 1981). Final adoption of the NSB comprehensive plan is expected in December 1982. See the 71 FEIS for a description of the interim comprehensive plan, NPR-A Land Use Study, and the Land Use Council (USDI, 1982).

5. Cultural Resources: Cultural resources affected by the activities of this proposal are the same as those described in the BF FEIS (USDI, 1979) and the 71 FEIS (USDI, 1982). Details of that description will therefore not be included here. Additional information (obtained since the BF and sale 71 FEIS's were written), supports the previous sales' information that ice gouging and water movement have rearranged most of the cultural materials on the ocean bottom, making any artifact-finds in water depths of less than 30 meters practically impossible. Shipwrecks and cultural resources may still remain preserved inside the 30-meter area if they are in depressions, or other sheltered locations. The tracts listed in the proposed Cultural Resources stipulation (Sec. II.B.1.c.) are tracts that have a medium chance of containing cultural resources (Dixon, 1978). However, for most of the area, which is less than 30 meters deep, the ice gouging hypothesis applies, reducing the probability of finding cultural resources to practically zero. Shipwrecks are located on the map in Technical Paper No. 6 (Tornfelt, 1982) as precisely as the information allows.

Onshore cultural and paleontological resources are described in the 71 FEIS (USDI, 1982) and this information is used in connection with OCS population figures to assess the impact from activities of this proposal (refer to Sec. IV.I.5. for impacts on cultural resources).

6. Visual, Wilderness, and Recreational Resources: The visual, wilderness, and recreational resources surrounding the proposed sand and gravel lease area are the same as those described in the BF FEIS (USDI, 1979; pp. 105-108) and the sale 71 FEIS (USDI, 1982; pp. 86-87).

7. Air Quality: The air quality along the Beaufort Sea is within limits set by the Federal and State of Alaska standards and is considered to be very good (sale 71 FEIS, USDI, 1982). Additional information regarding the air quality in the Alaskan Beaufort Sea area is given in the 71 FEIS.

F. MMS Studies Programs

1. Environmental Studies Program (ESP): To date, the OCS Environmental Studies Program (ESP) has not designed and funded any study specifically to determine sources, areal extent, and physical characteristics for aggregate fill material for artificial islands and causeway construction.

The information presented in various program documents such as the Environmental Assessment of the Alaskan Continental Shelf, Interim Synthesis, Beaufort/Chukchi 1978; the BF FEIS (USDI, 1979); and the 71 FEIS (USDI, 1982) were obtained from existing literature and corollary observations from the permafrost and geologic environment studies initiated in 1975. Many of the principal investigators involved in the investigations were experienced in arctic fieldwork prior to the OCS studies program. Their experience, and the additional funding provided by the ESP, along with primarily industry efforts, have accounted for what moderate level of information is now available for leasing purposes.

With the onset of a proposed sand and gravel sale in the arctic, ongoing studies in FY 82 and proposed studies in FY 83 and 84 will provide, either as a corollary function or as specific objectives in the study, additional information to enhance the aggregate fill data base.

Available data and the major bibliographic sources, prior to 1982, have been presented in the aforementioned program documents or are included within this EIS. Listed below are studies funded (FY 82) and proposed studies (FY 83 and 84) which will provide additional data through their annual or final reports.

FY	82	83	84
RU 105-Physical Characteristics of Permafrost	X	X	
RU 204-Offshore Permafrost	X	X	
RU 205-Ice-Covered Geologic Environment	X	X	X
RU 253-Subsea Permafrost	X	X	
RU 271-Arctic Offshore Permafrost		X	
P Unit-Distribution of Sand, Silt, and Gravel			X

2. Socioeconomic Studies Program: The Socioeconomic Studies Program (SESP) of the Alaska OCS Office of the Minerals Management Service was created to determine and assess the potential onshore economic, social, and cultural impacts from OCS oil and gas development. As a multi-year, multi-discipline program, the SESP conducts studies on the economic, social, and cultural aspects of diverse groups. The SESP focuses on a longitudinal investigation of the development process, beginning from the assembly of baseline information and hypothetical development scenarios to the monitoring of project development as it affects specific communities, regions, and the state as a whole. In addition, the program makes economic analyses and infrastructure assessments of rural and urban communities, regions within the state, and the state as a whole.

In offshore oil and gas lease sales in the Beaufort Sea conducted by this office the SESP identified the study area to include the North Slope Borough. The context of those studies completed for the joint federal/state Beaufort Sea lease sale ranged from an analysis of the petroleum development scenarios, outlining the technologies, industry costs, and supply prices of offshore Beaufort Sea hydrocarbon products, to an analysis of the local and statewide impacts on employment, population, and infrastructure. Work was done describing the effects of OCS development on the transportation systems and sociocultural systems, i.e., subsistence, family life, and social networks. A study describing the probability of locating cultural resources and the potential for disturbance was conducted for this sale. There was also an analysis of the government of the North Slope Borough and other institutions whose jurisdiction is within the Beaufort Sea Region.

Work completed by SESP for the second Beaufort Sea lease sale (sale 71, October 13, 1982) included additional analyses on the local and statewide economic and population forecasts, impacts on transportation systems, and sociocultural systems. These were updated versions of "CORE" studies completed for the joint sale which accounted for the cumulative effects of both Beaufort Sales. These studies have provided the source documentation for the social and economic impacts analyzed in this EIS. These studies have also been incorporated in pre-sale documentation for bidding systems, tract evaluations, mitigating measures, Secretarial Issue Documents (SID's) and post-sale evaluations of exploration plans conducted by the Alaska OCS Region. From September 1976 until early 1980, Peat, Marwick, Mitchell and Co. had the responsibility to hire subcontractors to perform the work required for impact assessment. In early 1980, the Alaska OCS Office took over the responsibility for hiring contractors to conduct the required studies. The following studies were contracted by the SESP for the Beaufort Sea Petroleum Development Region and the Alaska South Central Region.

Socioeconomic Studies Program Technical Reports

TR-3	Beaufort Sea Basin Petroleum Development Scenarios for the Federal Outer Continental Shelf: Interim Report
TR-5	Beaufort Sea Baseline Studies: Interim Report
TR-6	Beaufort Sea Region Petroleum Development Scenarios
TR-8	Beaufort Sea Region Man-Made Environment
TR-9	Beaufort Sea Region Sociocultural Systems
TR-10	Beaufort Sea Regional Natural Physical Environment
TR-11	Beaufort Sea Region Socioeconomic Baseline
TR-12	Anchorage Socioeconomic and Physical Baseline
TR-13	Anchorage Impacts of the Beaufort Sea Petroleum Development Scenario
TR-16	Governance in the Beaufort Sea Petroleum Development Region
TR-18	Economic & Demographic Impacts of the Beaufort Sea Petroleum Development Scenarios
TR-19	Man-Made Environmental Impacts of the Beaufort Sea Petroleum Development Scenarios

TR-20	Transportation Impact of the Beaufort Sea Petroleum Development Scenarios
TR-21	Natural Physical Environmental Impact of the Beaufort Sea Petroleum Development Scenarios
TR-22	Sociocultural Systems Impacts of the Beaufort Sea Petroleum Development Scenarios
TR-23	Socioeconomic Impacts of the Beaufort Sea Petroleum Development Scenarios
TR-28	North Sea and Canadian Beaufort Areas Analysis
TR-62	Beaufort Sea Statewide & Regional Demographic & Economic Systems Impacts Analysis
TR-64	Beaufort Sea Sociocultural Systems Update Analysis
TR-65	Beaufort Sea Transportation Systems Analysis

These Technical Reports are available to the public through the National Technical Information Service, 3285 Port Royal Road, Springfield, Virginia 22161.

IV.

ENVIRONMENTAL CONSEQUENCES

IV. ENVIRONMENTAL CONSEQUENCES

A. Basic Assumptions for Impact Assessment

The proposed action would result in the dredging of approximately 189.7 million cubic meters of fill material over a period of approximately 10 years. Table IV-1 indicates that as a result of OCS lease sales BF and 71 some 12 exploratory and 12 production islands will be constructed using fill dredged from offshore federal lands. The islands will be scattered over the lease sale area corresponding with the tracts sold during lease sales BF and 71 (see Fig. II-2 for tracts leased). The mean case scenario for artificial islands of lease sales BF and 71 was reduced by about 10 percent to 24 islands total. This was to account for a certain percentage of offshore islands being constructed by trucking fill material from onshore sites.

Dredging operations should begin sometime in 1983 with the deployment of one or two dredges--one dredge for each island constructed. Assuming an unrestrained operating period of 20 to 24 hours per day for each dredge, an exploratory island constructed in 10 meters of water composed of an intermediate mixture of sand and gravel could require 28 to 60 days to construct. The quantity of fill that would have to be dredged to construct the exploratory drilling island is estimated at 5.96 million cubic meters.

The production period phase of island construction is expected to begin in 1985 with the construction of one or more artificial islands (Table IV-1). Island construction is expected to continue an additional 9 or 10 years until a total of 12 islands are constructed. The islands are expected to require 9.9 million cubic meters of fill and two dredges to construct them in 24 to 50 days. The arctic construction season is approximately 70-80 days and dredges may be able to move to a second project during the same season thus lowering the demand for dredging vessels.

The crew complement on each of these dredging vessels and their support/dormitory scows will number between 40 and 60 individuals. During the peak of development activities total crew numbers could approach 500. Crew members may or may not be rotated.

The dredges which will be utilized in island construction will in all probability be hydraulic dredges. Two types of hydraulic dredges will probably see wide employment in the Beaufort Sea: cutterhead suction dredges and trailer suction hopper dredges. Each of these dredge types relies on vacuum pumps to mechanically lift disturbed sediments from the ocean floor to an internally contained bin called a hopper or to a pipeline for either deposition onto a barge or transport directly to the island construction site. The cutterhead dredge disturbs sediments by means of a rotating cone-shaped head which contains jagged teeth, while a hopper dredge utilizes a "draghead" containing scrapers and/or mechanical teeth. As the draghead trails behind the moving dredge, the sediments are vacuumed into ship-contained hoppers.

Some of these dredges are ocean-going vessels and capable of operations for 30 days or more without resupply. Others, especially the cutterheads, are portable, non-self-propelled units which cannot operate at sea without close support. For offshore operations in the Beaufort Sea it is envisioned that resupply for both types of units will come from outside the sale area. Support for the non-mobile dredges would be provided from warehouse and dormitory scows anchored near the workplace. Air support would be provided for work crew changes and delivery of emergency and perishable supplies.

Fill can be transported to artificial island construction sites by various methods. Hopper dredges may transport the material directly to the workplace and deposit the cargo through doors located beneath the hopper bins. This method would be employed if the ship were operating 2 to 4 miles near the construction site or if there were no transfer barges available. Barges are often used to transport fill when (1) large amounts of fill are required, (2) the point of excavation is several miles from the construction site, or (3) the area of deposition is too shallow (8-10 ft) for the dredge to operate in.

Dredges also use a form of slurry pipeline to transport fill. Hopper dredges, in particular, can deposit their cargo directly underwater to a specific location through a pipeline. Such a method can be used for the covering of pipelines or building of subsea earthen foundations.

Fill can also be transported via floating pipeline. Depending on the power of the dredges and pumps, fill can be pipelined up to 10,000 feet from the point of excavation. Once above sea level, the fill is spread by tractors over the surface of the island.

Besides utilizing dredges for Beaufort Sea island construction, trucks may also be employed. The properties of the ice formation along the Beaufort shore are such that trucks may safely drive out to about the 12-meter isobath. During a colder or warmer then average year this boundary may fluctuate as it marks the edge of the landfast ice zone. Artificial islands which are constructed within this zone may be emplaced entirely during the winter by gravel-bearing trucks. Further, islands within the landfast ice zone which were started by dredges but not finished by the end of the open-water season could be finished by trucking. A certain percentage of the islands constructed in federal waters as a result of lease sales BF and 71 will be constructed utilizing fill from onshore sources. Figure I-1 indicates those tracts in the lease sale BF and 71 areas which are usually covered by winter landfast ice where islands could be constructed by trucking gravel from onshore stockpiles. Other tracts within the lease area are also within the 12-meter zone; however, trucking fill material to these tracts may not be feasible due to the lack of onshore fill sources or because the haul distance is too great. The trucking of gravel is a preferred construction method because fill can be obtained from known borrow sources, trucking can be continued over a greater period of time than dredging operations, and may be more economical.

The volume of gravel required to build an artificial island can be reduced by any of the following means:

1. The use of retaining walls such as sandbags to reduce island erosion.

2. The use of a berm which has steep sloping sides where fill material would be deposited inside the empty center of the berm to form the island. The berm is built by discharging dredged fill through an underwater down-spout (pipeline) creating steeper sides than those formed when sediment is discharged by a spill barge.

3. The use of concrete or steel caissons. These structures may not be practical in less than 10 meters of water but will become increasingly necessary as drilling islands are built in deeper and deeper water.

4. The reuse of fill material from exploration islands. Fill material may be saved by the conversion of exploratory islands into production islands. The amount of islands that may be converted is of course unknown since the area has not yet been drilled. The conversion of half or more of the exploratory islands to production islands may be a possibility considering the economics in that the total dredge volume requirements may be reduced by some 30 million cubic meters.

For further and more detailed information see Technical Paper No. 7 "Methodologies of Arctic Dredging and Artificial Island Construction" (Roberts and Tremont, 1982).

1. Constraints on Dredging/Disposal Activities: Sea ice is the major constraint affecting dredging operations in the lease sale area. At present, dredges will operate primarily during the open-water season; the hulls of the dredges may be strengthened so that they can begin operation sometime during the spring breakup and extend operation into the early part of the fall freezeup. Invasion of sea ice into a dredging area will probably halt operations until the ice retreats. The open-water season and the sea ice regime are discussed in Section III.A.2.

Other constraints to dredging operations include the bathymetry and sea state; these constraints are related, at least in part, to the dredge design. There will be a minimum depth in which any particular dredge can operate and this will be a function of the draft. Also, there is a maximum operating depth for the dredge head. Dredging operations will cease when the wave heights exceed the design limit.

Also, depending on the extent, the presence of ice-bonded sediments or overconsolidated clays will slow or halt dredging operations in those areas where these phenomena are encountered. Permafrost and overconsolidated clays are discussed in Section III.A.1.

2. Major Projects Considered in Cumulative Impact Assessment: For purposes of cumulative impact assessment 15 major projects on the North Slope have been identified (see Table IV-2). For more information on each of the projects see Appendix B of the 71 FEIS (USDI, 1982).

3. Definitions Assumed for Impact Assessment: Impact assessment was done assuming that regulations listed in Section I and Appendices B and C control some activities associated with this proposal. The potential mitigating measures listed in Section II.B.1.c. have not been accepted by the Secretary and were not assured as part of the proposal. Lease terms and conditions and other operational requirements have not been developed or accepted by the Department of Interior. Therefore, all statements of degree of possible impact refer to residual impact without these regulations. Because of the nature of assessment, the wide range of variables, and, in many cases, the lack of numerical information regarding an activity or biological entity, impacts are expressed in relative terms. In order to aid the reader

Table IV-1*
Artificial Island and Dredge Requirements for Activities Resulting from Oil and Gas Lease Sales BF and 71

Estimated Schedule of Artificial Island Construction[1/]

Calendar Year	Exploration Islands	Production Islands	Operating Dredges[2/]	Construction Time-Per Island (Days)	Total Fill Dredged[3/] (Million Cubic Meters)
1983	1		1	28-60	5.96
1984	1	1	3	28-60	15.89
1985	2		2	28-60	11.93
1986	2		2	28-60	11.93
1987	3		3	28-60	17.35
1988	3		3	28-60	17.35
1989			0		
1990		3	6	24-50	29.80
1991		4	8	24-50	39.72
1992		4	8	24-50	39.72
Totals	12	12	NA		189.65

Source: MMS, Alaska OCS Region, 1982.

1/Includes only those islands which are constructed from offshore federal sources.

2/Assumes one dredge for each exploration island and two dredges for each production island. Dredge type is a 24-inch cutterhead dredge.

3/Dredged fill material volumes were derived from Tables II-2 and II-3 taking an average amount of fill between a 10-meter gravel natural-slope island and a 10-meter sand natural-slope island.

* Same as Table II-1.

Table IV-2
Major Projects Considered in Cumulative Impact Assessment

			Developmental Timeframe 3/			
Project Name 1/	General Location	Resource Estimate 2/	Exploration	Development Construction	Production 4/	Current Status (1981)
1. Prudhoe Bay Unit (PBU) Oil Production	Prudhoe Bay onshore	9.6 (oil)	1965-1969	1969-1985	1977-2006 1,500,000 peak	Peak production ongoing until 1987; declining thereafter
2. Prudhoe Bay Unit Waterflood Project	Prudhoe Bay onshore, causeway offshore	1.0 (oil)	NA	1981-1983 (construction)	1983 (waterflooding)	FEIS issued; all permits approved.
3. Alaska Natural Gas Transp. System and Sales Gas Conditioning Plant (SGCP)	Parallels TAPS corridor and Alcan Highway	26 (gas) (PBU)	1965-1969	1984-1989	1989-2016 2.0 bcf/day	FEIS issued; permits in progress for pipeline activity; Financing problems are delaying construction.
4. Kuparuk River Field	Approx. 25 mi west of Prudhoe Bay, onshore	0.4-1.3 (oil)	1970-1979	1981-1983	1982-2002 2000,000 bbl/ day	Permits issued for Phase I production (ARCO only); unitization being studied among field owners.
5. National Petroleum Reserve in Alaska	Northwest Alaska, west of Colville River	1.85 (oil) 3.26 (gas)	1944-1989	1987-1989	1990-1991 132,000 bbl/ day peak	Congress has authorized competitive leasing; sales held 1/82 and 5/82.
6. Sagavanirktok Delta area and Duck Is. Unit	12 mi east of Prudhoe Bay offshore	0.46-0.98 (oil)	1977-1982	1984-1986	1987-2000+ 200,000 bbl/day peak	Field is commercial; delineation drilling in 1982; Exxon proceeding with development planning & environmental studies.
7. Milne Pt., Gwydyr Bay & Pt. Thompson Units	North Slope onshore, west and east of PBU	0.48-1.1 (oil)	1972-1994 (all 3 fields)	1982-1984 (Milne Pt.)	1985-2000+ (Milne Pt.)	Series of discovery wells in 3 separate fields. Milne Pt. field commercial and will tie into Kuparuk pipeline; other fields subject to delineation.
8. Joint Federal/State Beaufort Sea Sale of 1979	Beaufort Sea Offshore - Return Is. to Flaxman Is.	0.75 (oil) 1.6 (gas)	1981-1989 and thereafter	1985-1588	1989-2014 150,000 bbl/ day peak	FEIS issued; sale in 12/79; exploration ongoing in winter season only. No discoveries yet.
9. Canadian Beaufort Sea (ESSO, Dome, Gulf acreage).	Offshore Mackenzie Bay, Canada	7-33 (oil) 60-180 (gas)	1973-1982 and thereafter	1982-1985 and thereafter	1986-2000+	Major discoveries subject of delineation. Operators proceeding with field development. EIS on dev. prod. in development and production in progress.
10. Arctic Slope Regional Corporation leasing	Northwest Alaska south & west of NPR-A	NA	1973-ongoing	NA	NA	Low level exploration ongoing; no discoveries.
11. Future State of Alaska leasing: offshore and onshore	Offshore Beaufort Sea, onshore east of PBU, offshore Chukchi Sea	NA (industry interest high)	1983 thereafter	NA	NA	State lease sales 34, 36, 39, 43, 44 coordinated with current OCS schedule. Little information available.
12. Future OCS Leasing: sale 85 and sale 109	Barrow Arch Offshore Chukchi Sea	1.3 (oil)	1985-1988 and thereafter	1989-1993	1994-2000+ 450,000 bbl/ day peak	Future OCS sales scheduled in 1985 and 1987 if technology is available; post sale activity speculative.
13. Arctic National Wildlife Refuge	North of Brooks Range, east of Canning River	NA	geophysical only	prohibited	prohibited	ANILCA requires studies of Refuge before geophysical work allowed. Act prohibits downhole operations.
14. North Slope Borough Capital Improvements Program (CIP)	North Slope Borough	Not relevant	Not relevant	1983-1985	Operation: 1983-1985+	Future revisions to CIP may include permanent road from PBU to Nuiqsut and satellite service center for Kuparuk field developments. Present CIP monies stimulate village economies on North Slope.
15. State Sale 34	Northeast Prudhoe Bay Uplands	NA	1983-1988	1988-1991	1989-2006(oil) 1990-2016(gas)	Lease sale held 9/82
16. OCS Sale 71	Diapir Field-Offshore Harrison Bay	2.38	1983-1988 5/	1990-1996 5/	1992-2013 5/	Ten-year leases offered Oct. 1982.
17. Future OCS Leasing Sale 87, and Sale 97	Diapir Field-Offshore Beaufort Sea	3.09	1985 and thereafter	1991 and thereafter	1993 and thereafter	Lease sales to be held in 1984, 1986.

NA = Not Available

1/ The numbering of projects in this table corresponds with the listing and further description of projects in Appendix B of the 71 FEIS (USDI, 1982).
2/ Resource estimates for oil expressed in billions of barrels; gas expressed in trillions of cubic feet.
3/ Developmental timeframes are approximate. Dates are fixed with timing of first commercial field development. Time frames for subsequent fields not indicated.
4/ Production estimates, when available, are expressed in barrels of oil per day.
5/ Time frame based on 5 year lease

in determining the relative extent of impact the following definitions are offered:

a. Biological Resources and Endangered Species: The following definitions were adopted from Dome Petroleum Ltd. et al. (1982).

A MAJOR IMPACT exists when a regional population or species may be affected to a sufficient degree to cause a decline in abundance and/or a change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not likely return that regional population or species, or any population or species dependent upon it, to its former level within several generations.

A MODERATE IMPACT exists when a portion of a regional population may be affected to a sufficient degree to result in a change in abundance and/or distribution over more than one generation of that portion of the population or any population dependent upon it, but is unlikely to affect the integrity of any regional population as a whole.

A MINOR IMPACT exists when a specific group of individuals of a population in a localized area and over a short time period (one generation) may be affected, but other trophic levels are not likely to be affected in a manner which is considered regionally significant, or the integrity of the population itself is not significantly affected.

A NEGLIGIBLE IMPACT exists when the degree of the anticipated biological effects are less than minor.

A SHORT-TERM IMPACT is likely to persist less than 5 years from the onset of the disturbance.

A LONG-TERM IMPACT is likely to persist more than 5 years from the onset of the disturbance.

b. Cultural Resources: (USDI, 1980).

VERY HIGH - Many cultural resources are expected to be present and disturbed.

HIGH - A few cultural resources are expected to be present and disturbed.

MODERATE - Significant possibility of both presence and disturbance of cultural resources.

LOW - Remote possibility of presence and disturbance of cultural resources.

VERY LOW - No cultural resources likely to be present.

c. Visual and Recreational Resources: (USDI, 1980).

VERY HIGH - Visual quality degraded to an extent that it affects all people in the area. Reduced recreational visitation to the area. Reduced property values.

HIGH - Visual quality degraded to an extent which affects most people in the area. Reduced recreational use of the area. Reduction in property values likely.

MODERATE - Visual quality degraded to an extent which affects about half the people in the area. No noticeable reduction in recreational use. No perceptible reduction in property values.

LOW - Minor degradation in visual quality. Most people accept the change. No reduction in recreational use or property values.

VERY LOW - No significant reduction in visual quality. Few people notice changes. No reduction in recreational use or property values.

d. Water Quality: (See Sec. IV.D. for high to low values.)

LONG TERM	more than 1 year
MEDIUM TERM	6 months to 1 year
SHORT TERM	less than 6 months
REGIONAL	greater than 3 square kilometers (greater than 1.2 square miles)
LOCAL	less than 3 square kilometers (less than 1.2 square miles)

e. Social Systems:

A MAJOR IMPACT occurs when primary subsistence resources (see Table III-3) are unavailable for more than a year.

A MODERATE IMPACT occurs when primary subsistence resources are unavailable for less than a year.

A MINOR IMPACT occurs when secondary subsistence resources (Table III-3) are unavailable for more than a year.

A NEGLIGIBLE IMPACT occurs when secondary subsistence resources are unavailable for less than a year.

B. Alternative I - Proposal

1. Impacts on Inupiat Social Systems: The following assessment relies on the discussion of likely gravel extraction activities found in Section IV.A. of this EIS and in Technical Paper No. 7 (Roberts and Tremont, 1982) as the basis for projected social system impacts. Time frames for gravel island construction are assumed to parallel lease sales BF and 71 developmental time frames, with an anticipated 12 exploration islands constructed during 1983-1988 and an additional 12 production islands projected during the 1984-1992 period. No new work camps are anticipated. Canadian Beaufort Sea dredging experience suggests that the approximate 50-person crew associated with a given dredging operation on the OCS would be housed on

barges at the site and might not be rotated during the expected 90-day dredging season.

Social system impacts most likely to occur with gravel leasing on the OCS would emanate out of the type of contacts most likely to occur with dredging operations and crew and any resulting disturbance to animal populations utilized for subsistence by local Inupiat residents. These effects would most likely be felt by North Slope Borough political systems on the one hand, and by hunting and fishing families and their associated villages on the other. A third potential area of region-wide effect would be a generalized attitude toward offshore mining, whether positive, negative, or relatively neutral, resulting from experience with dredging operations in the local area and the ability of local political institutions such as the North Slope Borough Planning Commission and Assembly to effectively influence decisions which are locally significant. For purposes of the present discussion, attitudes toward dredging will be discussed first, followed by potential population-induced effects and finally potential subsistence conflicts.

North Slope residents now have been able to observe construction of gravel islands in the nearshore area at Duck Island and Seal Island, and have formally negotiated an agreement concerning construction of another gravel island next to the highly sensitive and historically significant Cross Island. The ability of Inupiat social systems to effectively influence the location of a gravel island in this highly sensitive area has encouraged an attitude of cooperation and cautious optimism concerning the ability of local residents to protect the barrier islands. These islands have long been culturally significant and are continuously used as staging areas for present-day subsistence whaling, sealing, fishing, and bird hunting by local Inupiat residents. (Michael Jeffrey, 1982; see also North Slope Policy Review, July, 1982).

Inupiat local control over important decisions of cultural significance could be eroded if the number of uncoordinated, separate dredging operations on-going at the same time exceeded the capabilities of the North Slope Borough to plan and coordinate official responses. This does not appear to be the case with the number of gravel islands projected for this proposal and the time frames for their construction. At most three or four gravel islands per summer period would be constructed during exploration, and another four per summer period during the production phase. On the other hand, one can expect that Inupiat values and goals will be forcefully expressed if dredging operations interfere with locally based social and cultural practices.

An example of possible impacts from dredging is afforded by recent Nuiqsut experience with a North Slope Borough dredging operation on the Colville River delta. For the last 2 years, this dredge has been stockpiling gravel for use in local road and airstrip construction projects. It has provided local residents with employment and has provided the local village corporation with revenues from dormitory rent at a locally owned workcamp. The relatively simple technology associated with this dredging operation has been less intimidating to local residents than the generally "high-tech" equipment of the Prudhoe Bay oilfield. For these and perhaps other reasons, State Subsistence Division fieldworkers in Nuiqsut found a generally positive attitude toward the dredging operation throughout the Nuiqsut community (S. Pederson, personal communication).

a. Population-Induced Impacts: If dredging crews maintain barge dormitory housing near the dredges one would expect relatively little or no interaction with local village populations. Only if the Prudhoe Bay-Deadhorse airport were not exclusively used would there be any significant potential interaction from incoming or outgoing dredge operation crews.

b. Sociocultural Impacts: Similarly, regional level impacts on the North Slope sociocultural system resulting from OCS dredging and gravel island construction can be expected to be minor. If the Nuiqsut experience is taken as a guide, one can anticipate relatively mild community attitudes toward the dredge itself and relatively little interaction between local governments or other institutions with the relatively self-contained dredging operation. Without these significant local contacts, and given generally positive attitudes toward dredging, few sociocultural effects are anticipated.

c. Effects on Subsistence Harvests: Since it is likely that oil companies with leases will prefer to use gravel on or nearest their leases, if available, for earliest gravel island construction, current information on subsistence harvesting patterns and locations of harvesting activities in the Harrison Bay to mid-Beaufort Sea area are the most pertinent to the time frames for these proposed gravel islands. Associated impacts discussed here no doubt will overlap with oilfield activity associated with the oil leases themselves and cannot be completely separated from these expected effects. The reader is referred to maps and figures in Sections III.B. and IV.B.1. of the 71 FEIS for generalized and village-specific discussions of the continuing subsistence economy of the North Slope and ranges and seasons of subsistence use. The present analysis focuses on the most likely site-specific use conflicts between subsistence harvesting and gravel dredging activities.

Barrow, Nuiqsut, and Kaktovik are three villages along the Beaufort Sea coast which engage in fall whaling (early September to October) staged off the barrier islands. In contrast to the earlier spring whaling, fall whaling crews are smaller and they use 20- to 25-foot long motorboats, appropriate for the open-water conditions and longer distances traveled. During the 1982 fall whaling season, Nuiqsut and Kaktovik crews were hunting off Flaxman and Cross Islands. In 1973 Nuiqsut's whale was landed and butchered on Flaxman Island.

Cross Island's significance to the Inupiat is tied both to present day subsistence whaling, sealing, birding, and fishing but also to its position in history as a navigational landmark for early whaling ships and more recently as the whaling camp for the most famous Inupiat whaling captain, Taaqpak, who is revered both for his skill as a whaling captain and also for his calm persistence in teaching these and other skills to young Inupiat.

Other barrier islands which are extremely important for whaling, fishing, sealing and waterfowl hunting today are Pingok Island, in the Jones Island group, Tigvagiaq Island in Mikkelson Bay, and Pole Island in the Stockton Islands group. Foggy Island in the Foggy Island Bay-Sag River delta area was extensively used as a fishing and hunting camp during the 1920-40's period. Table III-4 provides a listing of culturally significant sites in the mid-Beaufort sea area from Brownlow Point to the east to Oliktok Point to the west. Although these islands are within state waters, the staging of subsistence activities from them and their historical, cultural, and present importance to the Inupiat people encourage extreme caution in allowing dredging activities and gravel island construction nearby in the OCS. If gravel structures or dredging activities were located so as to disturb traditional fall whaling, for example, this would have region-wide significance. Careful coordination by the RSFO of dredging and gravel island placement decisions with the North Slope Borough and the Alaska Eskimo Whaling Commission in Barrow would assure protection of these seasonal activities.

Additional sources include NPR-A Field Study 1, Summary: Land Use Values Through Time Barrow-Atqasuk Nuiqsut and Kaktovik Summaries, 1979; Libbey and Hall, Cultural Resources in the Mid-Beaufort Sea Region, May 1981; and Qiniqtuagaksrat Uluqqanat Inuuniagninisiqun, the Traditional Land Use Inventory for the Mid-Beaufort Sea, Volume I, 1980.

Summary: Social system impacts most likely to occur with gravel leasing on the OCS depend on the type of contacts or disturbance most likely to occur with dredging operations, crew and subsistence species utilized locally. Minor effects on North Slope Borough political systems, in the form of changing attitudes, increased coordination time and staffing and increased air and Marine transport contact through Prudhoe Bay-Deadhorse can be expected. Potential disturbance of subsistence whaling, sealing, fishing, and birding which is carried out on or near the barrier islands of Flaxman, Cross, Pingok, Tiguagiaq, Pole, and Foggy Island could have region-wide significance.

Conclusion: Major impacts on Inupiat social systems are unlikely. Low to moderate impacts could occur if Inupiat whaling crews/or whales were disturbed during fall whaling.

Cumulative Effects: This proposal adds one more leasing action and potential disturbance to the large number of oil and gas exploration and development projects, CIP program plans, and other projects on-going or imminent on the North Slope, in the arctic or along the OCS. In closest proximity to the present proposal, Federal Lease Sales BF and 71, state-leased tracts in the Beaufort Sea, continuing production of the Prudhoe Bay field, the Prudhoe Bay Waterflood Project, and development of Kuparuk field are the largest projects and those most likely to significantly affect Inupiat and state-wide population, sociocultural systems, and subsistence dependence.

According to projections completed in the 71 FEIS (USDI, 1982), the combined population expected from both lease sale 71 and the above cumulative projects would add approximately 34,847 people to the state's population. Over 22,000 people would be added to Anchorage's population; over 3,200 would be added to Fairbanks; 3,900 would be added to Southcentral Alaska communities outside Anchorage; and another 210 would be added to North Slope permanent communities. These assumed populations by Census area are based on MAP-model allocations of population for North Slope exploration and development for lease sale 71 and on USGS oil resource estimates current at the time (May 1982).

Since the North Slope Borough government and people are the least affected by actual population increase anticipated by these development projects, it might be argued that statewide and Anchorage-area impacts would surpass those felt by residents of the North Slope. Certainly the expected population-induced impacts of these cumulative projects will significantly increase infrastructure expansion in Anchorage, and to a lesser extent in Fairbanks and Southcentral Alaska. Growth of housing, businesses, government services, school enrollments and facilities, water, sewer, telephone, communications and all other facilities and services needed and demanded by a large influx of new residents is likely to change these cities and regions to more urban variants of their present states with accompanying "boom town" crime and other social problems during peak construction periods.

Changes in the North Slope Borough will not be as dramatic as those already experienced in initially setting up oil and gas operations on the North Slope. The initial "enclave" model of Prudhoe Bay development is being maintained and traditional Inupiat communities are not being overrun by oilfield workforces. On the other hand, the North Slope region as a whole is being forced to shift in relationship with the rest of the state as state and southcentral population grows and the oil industry increasingly dominates the Anchorage and southcentral-railbelt economies and societies. The increasingly complex linkages of North Slope government and other institutions to statewide government and industry are built up over time without the appearance of radical change (McBeath, 1981). In the lives of Inupiat families and communities, these developments are now part of the ever-changing present with which they are becoming more accustomed (see Kruse et al., 1981).

As a community, Barrow has and will continue to experience, the most disruption of traditional ways of life. As the seat of regional government, Barrow serves as the liaison to government and industry and is most directly affected by the speeding up or slowing sown of exploration and development timetables. Computerized permitting procedures, well-budgeted studies of Inupiat Cultural Resources, and Elders Conferences are three tools which help define and maintain the management goals and objectives of the NSB. Similarly, community goals and objectives are being realized through continuing CIP projects in housing, schools, utilities, and services. In spite of these improvements, Barrow community conflict is still high relative to other NSB villages, and incidences of alcohol and drug abuse and other family and individual problems still are major concerns of residents of the community.

These regional and community changes cannot be traced to the present proposal, nor to any single oil and gas project now underway in the Beaufort Sea. But when all of the oil and gas projects are accumulated for this and adjacent areas in the Canadian Beaufort and Chukchi Seas the population dynamics alone suggest fundamental structural changes for the state, the Southcentral region, Anchorage, Fairbanks, and the North Slope economy and society. It is likely that the most problematic areas at the present time will be seriously exaccerbated during peak construction or development periods. At the same time, it is likely that as these problems become better defined, solutions and remedies to their most serious consequences will also become more accessible to policy and program implementation.

Cumulative Effects on Subsistence: Expansion of OCS leasing in Beaufort Sea, gravel dredging, and gravel island construction for exploration and development together could have significant region-wide effects on subsistence use if unmitigated. If the combined noise and disturbance in the Beaufort Sea altered bowhead whale migrations, altered polar bear, seal, and fish migration routes, reproductive behavior or population levels, then subsistence take and use could suffer. Increased noise from seismic exploration, aircraft, boat traffic, and dredging operations could, if allowed to exceed tolerable limits, affect fish and wildlife productivity in the area, displace them from the area, or otherwise compound the difficulties already encountered by arctic hunting and fishing families. (See also the discussion of cumulative effects on specific biological resources, in particular discussions regarding birds, marine mamals, fish and endangered species (whales).

The increasing industrial activity associated with OCS exploration and development in the Beaufort Sea could also discourage subsistence hunting and fishing on the OCS if it preempted favored hunting and fishing location; disturbed whales, seals, or other subsistence species while they were being hunted by local Inupiat hunters. Restrictions on noise disturbance of biological resources of the area would help to protect subsistence dependence on these biological resources. Monitoring programs which acknowledged subsistence concerns and allowed for non-disturbance of subsistence practices could also help prevent the erosion of these cultural practices in the face of increasing industrialization of the area.

Disturbance of terrestrial habitat and wildlife dependent upon this habitat could reduce subsistence take of these species. Caribou is a primary subsistence resource of Barrow and Wainwright; caribou and moose are primary subsistenct resources of Nuiqsut village; caribou and sheep are primary subsistence resources of Kaktovik villagers. Oil and gas exploration and development in NPR-A, the Arctic Wildlife Refuge, on proposed state-leased tracts in the Prudhoe Bay Uplands (sale 51) and at Icy Cape (sale 53) could affect subsistence harvests of these species if habitat disturbance reduced species abundance.

Restrictions on hunting by the oul and gas industry have already altered some-what unting paterns in the vicinity of thes service bases. As the industry expands, these hunting restrictions could be serious impedimants to cost-efficient hunting for neighboring villages, particularly Nuiqsut, and to a lesser extent Kaktovik, Barrow, Atqasuk, and Wainwright. Opening of the North Slope Haul Road within the NSB to unrestricted traffic could seriously reduce availability of caribou, moose, sheep, and other trestrial species hunted for subsistence use. Opening access to these favored resources would encourage indiscriminate harvest of these species by sport hunters from more populated areas of the state, thereby reducing the availability of these species for subsistence users. Nuiqsut, Kaktovik and Anaktuvuk Pass would most likely be affected by the effects of the Haul Road accessability.

Conclusion for Subsistence: Major impacts on subsistence patterns and local subsistence uses would occur if bowhead whales and caribou were not available for more than a year. This is unlikely. Low to moderate impacts will probably occur during some of the years that these projects are ongoing.

Effect of Additional Mitigating Measures: An orientation program which included subsistence use areas, concerns, species and seasons would encourage voluntary non-interference with subsistence activities on or near the barrier islands named above. Recognition of cultural differences and respect for the cultural, social, and economic significance of subsistence to Inupiat people would minimize any negative effects resulting from contact between dredging crews and Inupiat residents of the area.

The information to lessees encouraging no interference with subsistence activities also alerts dredging operators to potential conflict, thereby reducing the liklihood of disturbance.

Disturbance of whales or whaling crews during fall whaling could be avoided by an effective whale monitoring program which recognizes subsistence whaling activities as legitimate grounds for ceasing operations. Coordination by the RSFO with the NSB and the AEWC would assure that disturbing activities and associated noises are minimized or stopped during fall whaling (September-October).

Unavoidable Adverse Effects: If subsistence concerns are addressed through coordination by the RSFO with the NSB and AEWC in an acceptable whale monitoring program, and if dredging crews and lessees receive orientation to and abide by restrictions which avoid disturbing subsistence activities based on or near barrier islands then there would be no unavoidable adverse effects from dredging.

2. Impacts on Biological Resources:

a. Impacts on the Stefansson Sound Kelp Community:

The Stefansson Sound kelp community or Boulder Patch has been described by Dunton and Schonberg (1980) as "an area of cobbles and boulders with attached kelp and invertebrate life." These cobbles and boulders occur in patches of various sizes and densities and despite a seasonal influx of sediments from the nearby Sagavanirktok River, the Boulder Patch remains a non-depositional environment. This allows this unusual habitat to exist, coupled with the fact that the offshore islands and shoals restrict the passage of large, deep-draft ice preventing physical disruption of the rocks. Other smaller areas of boulders and cobbles with attached kelp exist southeast of Belvedere Island in the Stockton Island chain, in western Camden Bay, and seaward of Flaxman Island at the 10-meter isobath. Other algal beds also exist; however, these areas are small, do not contain kelp, and do not possess the diverse epilithic fauna that characterize the Boulder Patch. (Refer to Sec. III.B.2. for a more detailed description.)

Effects of the proposed action on the Boulder Patch habitat would largely result from any dredging activity occurring within or adjacent to the area. Under Sale BF (Federal/State joint sale) Federal Stipulation No. 7, oil and gas operators holding leases on tracts within this region are required to conduct environmental surveys prior to any operation. Based on these surveys, protective measures may then be required in order to prevent adverse impacts to these habitats. In the event that the sand and gravel lessees are not the same as the oil and gas lessees on these tracts, this stipulation would not apply. Dredging allowed within these areas could result in permanent damage through destruction of habitat, or short-term impacts through suspension of sediments during the dredging operation.

This diverse community exists because of the presence of hard rock substrate and the absence of sediment deposition and physical disruption. The disturbance or removal of the vegetation or hard rock substrate would therefore cause permanent or long-term damage to these habitats. Experiments by Dunton et al. (1982) have shown that denuded (vegetation removed) plots were slow to recolonize and were still mostly bare after 3 years. Fifty percent of the tested surfaces remained bare on all plots, and over 75 percent of the substrate was uncolonized on most plots. Boulders that were turned over by natural processes also exhibited sparse or no recolonization. The significance of the carbon or energetic contribution of the Boulder Patch to the Stefansson Sound ecosystem is not presently known. A small portion of the estimated 146 x 10^6 grams per year of carbon contributed by the kelp to Stefansson Sound is consumed directly by herbivorous organisms. The removal or destruction of a significant portion of this area could dramatically alter the species composition, and would almost certainly reduce the biomass and species diversity resulting in a major impact to this area.

Dredging or island construction operations adjacent to these areas would cause some suspended sediments to be transported through these productive areas. Such events would be temporal in that their duration would be identical to the duration of the dredging operation. Impacts resulting from such operations, however, would be negligible if dredging operations are located a sufficient distance upstream. Safe distances would need to be defined on a case-by-case basis; however, a minimum distance may be about 600 meters which corresponds to the maximum distance for dispersion of fluid mud created by slurry overflowing from a dump barge (Northern Technical Services, 1981a). As previously stated, these habitats are existing in non-depositional areas. This coupled with the location of the Boulder Patch off the mouth of the Sagavanirktok River with its large annual input of sediment into this region suggests that any sedimentation produced during dredging or construction operations located adjacent to the Boulder Patch would not significantly affect this area. Ambient levels of suspended sediments produced by the river during breakup would generally exceed most levels produced by these operations.

Additionally, winter construction and stabilization of an exploration gravel island (Exxon's Drill Site OCS-Y0191) located at the westernmost edge of the Boulder Patch did not result in significant adverse effects to this diverse biological community within the first 6 months following construction (Toimil and England, 1982). The amounts of siltation observed appeared to be within the tolerance of the organisms making up this community around the island. Observations made during and following construction (early March to August, 1981), showed a thin coating of silt (3 mm) on rocks, kelp, and collecting apparatus during May and an absence of measurable sedimentation later in August. Current velocities recorded in July and August were of sufficient duration and magnitude (up to 52 cm/sec) to erode and transport materials deposited during island construction.

Conclusion: Dredging and island construction operations conducted within the Boulder Patch areas of Stefansson Sound would result in permanent or long-term damage to this diverse community. This could be considered a major impact if any portion of this unique habitat is disturbed. The ecological ramifications of such damage are unknown; however, a significant reduction in biomass and species diversity would result in areas disturbed by dredging or covered by gravel islands.

Dredging and island construction operations conducted in areas outside and adjacent to the Boulder Patch would result in short-term, negligible impacts if operations are located a safe distance (greater than 600 meters) upstream. Sedimentation resulting from such operations would likely be transported through and away from any sensitive areas due to high current velocities during the open-water period.

Cumulative Effects: In addition to the proposed sale, other present or proposed development in offshore federal and state waters could result in impacts to the Boulder Patch habitat and biota. These development projects include the joint Federal/State Beaufort Sea sale of 1979, the Sagavanirktok Delta area and Duck Island Unit oil and gas development, and potential dredging operations conducted in State of Alaska territorial waters in the vicinity of the Boulder Patch.

These impacts would largely result from island construction and dredging associated with these projects. The types of effects from these activities would be similar to those discussed above. These activities would produce turbidity plumes which could intrude into the boundaries of the Boulder Patch and result in deposition of sediment. However, given the non-depositional nature of this area (as discussed above), significant sediment amounts would probably not remain long (less than 1 year) and the resultant effects on the Boulder Patch habitat would be negligible.

Smothering of habitat within the Boulder Patch as a result of gravel island construction is mitigated by Federal Stipulation No. 7 and State Stipulation No. 5 of Sale BF. These stipulations require the oil and gas lessees on tracts containing portions of the Boulder Patch to conduct surveys to determine the extent and composition of biological populations and habitats and the effects of proposed or existing operations on these populations or habitats. As a result of these surveys the appropriate state or federal authorities may require the lessee to mitigate adverse impacts to these resources by relocating the operation, altering the timing of the operation, or modifying the operation in such a way as not to affect these resources adversely. As a result of these stipulations no island construction is expected on areas containing Boulder Patch habitat. Cumulative effects are therefore expected to be negligible as compared to the major effects that could occur as a result of the proposal.

Effects of Proposed Mitigating Measures: Adoption of the proposed stipulation requiring environmental surveys and possible subsequent protective measures would ensure that significant biological communities such as the Boulder Patch would be protected from degradation resulting from dredging and other operations proposed by sand and gravel lessees. Additionally, adoption of this measure would ensure consistency with Sale BF, Federal Stipulation No. 7, which places similar requirements on oil and gas lessees.

Involvement of a Biological Task Force would ensure the adequacy of survey designs and results in enforcement of this stipulation. The task force could provide the RSFO with technical advice in interpreting the results of these surveys and formulating additional or subsequent protective measures. The task force could also provide continuity of control between oil and gas lessees and sand and gravel lessees.

Unavoidable Adverse Effects: Should dredging and island construction be permitted within the Boulder Patch, all of the impacts mentioned above would be considered unavoidable. Mechanical disturbance induced by dredging would result in permanent or long-term damage to the biota and supporting substrate.

Island construction could cover a portion of this community under the "footprint" of the island. Turbidity plumes from dredging or island construction upstream from these areas would necessarily result in sediment in the water column and temporary deposition of sediment.

The effects of turbidity could be minimized but not completely eliminated through use of special design features in the dredging equipment such as a submerged diffusor system at the discharge point, or silt curtains downstream of an operation. Use of these devices, however, should be considered on a case-by-case basis as more site-specific information is known.

b. Impacts on Plankton, Benthic Invertebrates, and Fish Resources: In this discussion the impacts on the three categories of biota (plankton, invertebrates, and fish) are consolidated because of their relatively close trophic interdependencies. Further, most of the causes and effects resulting from sand and gravel leasing are shared in common by at least two of these categories.

Dredging-induced effects on marine plankton, benthos, and fish have been described recently in several reports and studies. The most notable are a series of studies from the Dredged Material Research Program (DMRP) directed by the U.S. Army Corps of Engineers. Additionally, another group of reports and studies concerning effects of dredging and gravel island construction in both the Canadian and Alaskan Beaufort Sea regions has emerged (Beak Consultants, Ltd., 1978; Canada, Fisheries and Marine Service, 1977; Northern Technical Services, 1981a; Northern Technical Services, 1981b; Toimil and England, 1982; Pelletier and Wilson, 1981; and Pessah, 1982).

These reports generally concluded that effects on marine biota from dredging and disposal or island construction operations would be restricted to the immediate vicinity of the operation and the resultant turbidity plume and that, beyond these limits effects would be negligible. Effects on marine biota (plankton, benthos, and fish) would result from disturbance (mechanical agitation) or destruction of habitat in the dredged area, increased turbidity or suspended sediments in the water column, smothering of organisms, alteration of habitat down current from the dredge site or in the island construction area, and entrainment of aquatic organisms in the dredging device. Effects on aquatic biota in other regions have resulted from resuspension of pollutants or heavy metals entrained in bottom sediments and by alterations of the physical oceanographic regimes at the dredging or disposal sites.

Habitat Disturbance: Disturbance of habitat in this discussion would result from both the actual excavation or mechanical removal of bottom substrate, and the deposition of overburden during dredging, and sand and gravel during island construction.

The most obvious and direct effect from the proposed action would be the alteration or destruction of benthic habitat resulting from the mechanical removal of bottom substrate during the dredging operation. Most, if not all, benthic organisms reside either on top of or within the top 5 to 15 centimeters of the sea bottom. The removal of this top layer is a certainty during dredging which will ultimately lead to removal and death of benthic organisms (fish and invertebrates) and loss of habitat. The amount of benthic habitat that would be disturbed is unknown; however, by making several assumptions, certain estimates can be produced. If it is assumed that 12 exploration and 12 production islands are constructed at the 10-meter depth with either sand or gravel and with natural side slopes, then about 189.65 million cubic meters would be required (refer to Table IV-1). Further, if it is assumed that dredging is limited to 10-meter deep excavations, then approximately 19 square kilometers of seafloor would be disturbed. This represents only a small fraction of the total lease area (less than 0.2%), with the upper limit being smaller than one lease block (22.9 km^2). In reality, however, these estimates may be substantially greater or less depending on several factors including the actual depth of the overburden (material overlaying the actual construction material), the actual number of islands required, and the actual depth of excavation. Recolonization of these disturbed sites would probably begin immediately after dredging stopped (Heath et al., 1982 and Pessah, 1982). The rate of recolonization and the new community composition would depend on the degree of change in the substrate type (grain size of the predominant sediments), the changes in local physical and chemical oceanographic regimes (currents, depth, salinity, dissolved oxygen, etc.), and the tolerance of the recolonizing organisms to these changes. The benthic populations (fish and invertebrates) found in this portion of the lease area are seemingly adapted to withstand changes of this type, because of natural processes which cause unstable bottom sediment conditions. The processes include strudel scour, ice-gouging, and storms.

Strudel scour occurs in the nearshore areas of major river deltas during spring breakup. Flood water from river breakup eventually funnels through cracks and holes in the ice and creates scour depressions as deep as 4 meters and as wide as tens of meters across (Reimnitz and Barnes, 1974). Ice gouging occurs in waters less than 5 meters, through the grounded ice or stamukhi zone, and seaward. The greatest density of gouges (up to 100 or more per kilometer) occurs in the 15- to 30-meter-depth range. Ice gouging is reported to be capable of reworking the top 20 to 50 centimeters of seafloor sediments in a period of 50 to 100 years. More frequent (5-10 years) and intensive reworking of sediment occurs inside the 15-meter isobath during open-water seasons with intense fall storms (Barnes and Reimnitz, 1979).

As a result of these adaptations, it is anticipated that recolonization would be complete in less than 5 years. Heath et al. (1982) concluded that in dredged areas near Herschel Island in the Canadian Beaufort Sea, recolonization was nearly immediate by mobile macrobenthos and by sessile benthos brought in by water movement. They also found that species diversity was lower after dredging operations but that biomass was higher. They predicted that recolonization would be relatively complete in about 2 years. A conservative estimate for complete recolonization of benthic fauna in the lease area would be 2 to 5 years.

A loss of both organisms and habitats would also occur as a result of smothering at the overburden disposal site and island construction site. The area that would be covered by overburden disposal is not known. However, a conservative estimate would be equal to the total area disturbed, assuming that no overburden was redeposited in the original excavation. Thus, it is possible that 19 square kilometers could be covered by overburden. The average area coverage at the base of a gravel island is about 7.8 hectares for exploration and 11.2 hectares for production islands (10-meter depth). Considering the construction of 12 exploratory and 12 production islands, the loss of habitat would be about 228 hectares (2.28 km^2). Therefore, the total area that could be covered by both overburden deposition and island construction is 21.3 square kilometers. Recolonization of these disposal areas would be subject to the same constraints as those mentioned above for the dredged areas. It is expected that these areas would change in species composition because of changes in substrate type. However, the rate of recolonization would remain short-term (2-5 years). Pessah (1982) reports that recolonization started immediately after completion of (Esso's) Issungnak Island with 7 to 23 species per square meter in the spoil disposal zone compared to 29 to 47 species per square meter in the background zone. Studies of (Esso's) Isserk F-27 artificial island showed no significant trends in benthic invertebrate species' diversity or biomass related to the construction of the island.

In summary, benthic habitat disturbance related to dredging, overburden disposal, and island construction could affect about 40 square kilometers within the lease area. This represents less than 0.5 percent of the total lease area. Recolonization of these areas would be short-term (2-5 years), with unknown changes expected in community composition. Locally (in the immediate vicinity of each dredging operation) impacts to the affected benthic communities would be considered moderate (with a loss of organisms and habitat) and short-lived. From a regional perspective, however, the impacts resulting from habitat disturbance would be short-term and negligible.

Turbidity: Increased turbidity or suspended sediment concentrations resulting from dredging or island construction would produce some adverse effects to marine biota in the vicinity of the sediment plume and deposition zone. Sediment plumes created from such operations are generally from 1 to 5 square kilometers in areal extent (Refer to Sec. IV.B.3.). Deposition would generally occur within the range of the plume with significant portions settling out a short distance from the source. Effects from turbidity in these zones are generally short-term with recovery of organisms occurring in a matter of hours or days after operations cease. Organisms affected by sediment plumes include phytoplankton, zooplankton, filter-feeding infaunal invertebrates, epibenthic invertebrates, and fish.

Phytoplankton would be affected by sediment induced light attenuation, which would result in a reduction in carbon assimilation (photosynthesis). This would lead to a decrease in growth and reproduction, and hence a decrease in primary productivity in the area of the sediment plume. Considering the relatively small area of the plume, such an impact would be minor.

Zooplankton and filter-feeding benthic invertebrates could suffer a reduction in feeding efficiency through ingestion of sediment particles. While some organisms can metabolize ingested sediment, such particles would displace more nutritious food particles (e.g., organic detritus and other plankton) and lead to a decline in growth and reproduction. Again, this would be a minor impact.

Fish and some mobile epibenthic invertebrates caught in a sediment plume could suffer some respiratory malfunctions by sediment particles clogging or abraiding gill surfaces. Research conducted through the DMRP (O'Connor et al., 1976) has shown that fishes could succumb if sufficient damage to gill surfaces occurs. However, mortality generally occurs at concentrations higher than those expected in dredging operations.

Generally, bottom-dwelling fish were found to be the most tolerant and filter feeders the most sensitive, while early life stages were more sensitive than adults. Most marine species in the Beaufort are considered bottom dwellers. Bioassays using Fuller's earth suspensions and marine species from temperate areas yielded 24-hour LC_{10} values (lethal concentration to 10 percent of the tested organisms during 24 hours of exposure) of 10 grams per liter (g/l) or greater for the more tolerant species, between 10 and 1 g/l for sensitive species, and less than 1 g/l for highly sensitive species. Further, it was found that the effect of finely divided solids on fish was dependent not only on concentration but on particle size distribution and the angularity of suspended particles. Natural sediments were shown to be less harmful than mineral solid suspensions.

For the most part, significant adverse impacts to fish and epibenthic invertebrates are not expected from turbidity. Given that most fish and certain epibenthic invertebrates (mysids, amphipods, and decapods) are mobile, it is reasonable to assume that some of these organisms could escape the relatively small, turbid area created by a dredging operation. Also, these organisms, especially the sessile epibenthic forms are occasionally exposed to naturally occurring suspended sediment concentrations approaching or above those expected from the dredging operations.

The construction of Sohio's Endeavor and Resolution Islands by barge dumping produced concentrations within 20 and 10 milligrams per liter (mg/l) of ambient concentrations (8-12 mg/l) at downstream radial distances from the construction site of 340 and 1,730 meters, respectively (Northern Technical Services, 1981b). In the Canadian Beaufort, suspended solids in turbidity plumes during construction of gravel islands were on the order of 300 to 600 mg/l at the discharge site, with rapid declines with distance (Pessah, 1982). Predictions of concentrations for dredging operations off Prudhoe Bay in the Alaskan Beaufort Sea were less than 200 mg/l from mechanical agitation at the dredge cutterhead and between 100 and 300 mg/l at 100 meters downstream of the dump barge as a result of overflow from initial loading (Northern Technical Services, 1981a). All of the above concentrations are far below the 24-hour LC_{10} concentrations listed above.

The most significant source of increased turbidity may occur from loading operations at the dump barge. Overflow directly beneath the barge would likely yield 10,000 to 20,000 mg/l and could reach 100,000 to 500,000 mg/l for a worst case (Northern Technical Services, 1981a). However, the duration of these concentrations would probably not be long enough (less than 24 hours) to promote acute responses in fish. Such concentrations would settle out rapidly. They would form a mud flow and blanket the benthic environment, smothering some benthic organisms. This mud flow is actually a density current which may extend as much as 300 to 600 meters from the point of discharge. Effects from such flows may be mitigated by positioning dump barges over the cut behind the dredge, allowing the excavated portion of the sea bottom to restrict and contain the fluid mud. Recovery of such areas would be similar to that discussed above for disturbed areas.

The deposition of sediment down current from a turbidity plume would probably not produce effects dissimilar from sediment deposition occurring from natural processes. Deposition measurements taken from construction of Endeavor and Resolution Islands resulted in a worst-case prediction that deposition would be less than 10 centimeters within 100 meters and less than 1 centimeter within 300 meters (Northern Technical Services, 1981b). Some minor disturbance to benthic communities would be associated with the light deposition; however, recovery would occur quickly. Burrowing infaunal invertebrates such as polychaetes and siphonate bivalves tend to survive well under these conditions. Certain surface-dwelling crustaceans may succumb under the higher levels of deposition; however, due to their mobility recolonization could occur rapidly. Generally, impacts to benthic communities resulting from deposition of sediment from the sediment plume down current from the island construction or dredging site would be negligible.

Entrainment: Entrainment of organisms in the dredging device would likely result in direct mortality for most of the organisms entrained. Benthic organisms entrained from the area of excavation would suffer the greatest mortality, while fish mortalities would be minor.

Concerning fish, two possibilities exist. The noise and turbidity created by the operation could cause fish to avoid the dredging site, thus minimizing fish entrainment mortalities. Or, the introduction of benthic organisms into the water column within the sediment plume created by the mechanical agitation of the sediments could attract fish that are feeding on these organisms, thereby increasing mortalities.

Quantitative results from a study concerning this matter conducted in the Canadian Beaufort are inconclusive (Pelletier and Wilson, 1981). However, they did show that arctic species such as cod, sculpin, and arctic ciscos could be entrained. Considering that fish densities in the lease area are low and that the area is relatively far from the nearshore migration routes of anadromous species, entrainment would occur only to a relatively small number of marine fish. From a regional context this impact would be negligible.

Pollutants: Resuspension of trace metals and other pollutants in toxic proportions is not anticipated. The lease area is considered pristine with very low naturally occurring accumulations of heavy metals in the bottom sediments. Therefore, no effects to the biotic community from metal assimilation is expected. Nutrients may be released into the water column from overflow operations and result in a beneficial side effect by countering any decline in primary productivity induced by turbidity. Detrimental effects of nutrient release would not be expected.

Conclusion: Operations resulting from the proposal could produce major local adverse impacts on benthic invertebrates. Local impacts to fish and plankton would be minor. Such impacts would include loss and disturbance of up to 40.3 square kilometers (0.5% of the proposed lease sale area) of benthic habitat, direct mortality by smothering or entainment, and a reduction in primary productivity. Most, if not all, of these harmful effects would be restricted to the immediate vicinity of each construction or dredging area, with recolonization occurring within a short period (less than 5 years). From a regional perspective these impacts would be negligible.

Cumulative Effects: In addition to the proposed sand and gravel lease sale other projects (present and future) associated with oil and gas development in the Beaufort Sea and North Slope region could result in cumulative impacts on the marine biota of this region (plankton, benthos, and fish). These projects include the Prudhoe Bay Waterflood Project, Sagavanirktok Delta and Duck Island Unit Project, the joint federal/state Beaufort Sea Sale of 1979 (BF Sale), future State of Alaska leasing in offshore waters, federal OCS Sales 71, 87, and 97, and the possibility of tankering oil from the Canadian Beaufort Sea development through the Alaskan Beaufort Sea. Cumulative impacts from these projects would result from oilspills, drilling discharges, causeway construction, gravel island and pipeline construction, and sand and gravel mining (dredging) in state waters.

Oilspills occurring as a result of state and federal offshore lease sales and tankering of Canadian oil would result in lethal and a variety of sublethal effects on marine plankton, benthos, and fish (Refer to the Sale BF (USDI, 1979) and sale 71 (USDI, 1981) FEIS for a more detailed discussion).

Surface slicks created by oilspills would likely result in complete mortality of all of the planktonic organisms (algae zooplankton, benthic larvae, and fish larvae and eggs) contacted by the oil. Winter oilspill occurring under the ice would likewise result in lethal effects to the epontic communities inhabiting the ice subsurface. Such effects in offshore waters would generally result in short-term, local reductions in marine primary productivity with subsequent subtle effects on the marine food web. In all likelihood the areas affected by oilspills would begin to recolonize as the oil dispersed and degraded, leaving only negligible effects on these marine biota over the long term.

Oilspills reaching nearshore habitats and bottom sediments in more offshore areas could produce effects of greater magnitude than those mentioned above Contamination of bottom sediments and nearshore areas where natural mechanical degradation processes are generally absent (lagoons, marshes, or a tidal flats), could result in moderate long-term, local effects. These effects include mortality of benthic fauna and avoidance by fish and invertebrates in such habitats which would likely persist for 10 years or longer. Oil contacting critical habitats such as fish overwintering areas could result in long-term declines in regional populations of certain anadromous species (arctic and least cisco).

The magnitude and number of spills resulting from all of these projects is unknown. Based upon current resource estimates for sale 71 and sale BF, and nationwide oilspill statistics, a total of eight spills greater than 1,000 barrels and four spills greater than 10,000 barrels are expected over about a 30-year period. An additional unknown quantity would be expected from state leasing, future OCS leasing, and Canadian tankering. In contrast to the proposal (sand and gravel leasing) which would produce only negligible long-term, regional effects, oilspills resulting from these other projects could produce moderate long-term regional effects to certain fish populations. Given the great resiliency of benthic and planktonic populations in this region, regional effects would be negligible. However, some moderate, long-term effects to benthic communities could occur in localized areas contaminated by oil.

Discharges of drilling effluents (primarily muds, cuttings, and formation waters) would also produce adverse effects on these marine organisms. These effects generally result from either smothering of benthic organisms or contamination of sediments in the immediate vicinity (hundreds of meters) of the discharge. The prinicpal effect of these discharges would be to reduce the biomass of benthic life (primarily invertebrate fauna) within a few hundred meters of the discharge. These discharges are regulated by stipulations in both the Sale 71 and BF lease areas, and by the Alaska Department of Environmental Conservation and U.S. Environmental Protection Agnecy in both federal and state waters. The stipulations and regulation basically prohibit discharge of formation waters into waters less than 10 meters deep, prohibit the discharge of oil contaminated muds and cuttings, and regulate the discharge of muds and cuttings in a variety of situations. The intent in this regulation is to ensure that these discharges do not violate state and federal water quality standards.

The number of discharge sources (platforms or islands) could be as high as 17 (possible number of exploration and production platforms) for the BF sale area, 4 for the Sagavanirktok Delta/Duck Island unit, and an unknown number for the other state and federal sales. From a regional context the impact to the benthic community from these discharges would be negligible.

The construction of gravel islands and pipelines in all of the proposed and existing lease sales would also result in adverse impacts on these organisms. The effects produced would be similar to those discussed above for the sand and gravel leasing proposal. Briefly, benthic habitat would be disturbed by dredging, island construction, disposal of overburden, and pipeline trenching. Benthic organisms would be buried or killed in the process with recolonization occurring over the short term (2-5 years). Turbidity produced by these activities would result in a decline in primary productivity, and some irritation and feeding efficiency to fish, zooplankton, and epibenthic invertebrates. Recovery of the affected areas (usually less than 5 km^2) in each operation, would be within hours or days after cessation of the activity. Assuming that all 23 exploratory island and all 16 production islands are constructed for the BF and 71 areas, this would yield 16 islands in addition to the 24 proposed to be constructed under the sand and gravel proposal. This could increase the amount of benthic habitat disturbed from that presented in the proposal by about 60 percent. If it is assumed that 1.4 hectares of habitat is disturbed for every kilometer of pipeline constructed (USDI, 1979), then an additional disturbance of 3.9 km^2 would be expected for the 277 kilometers of pipeline proposed for both Sale BF and 71. An unknown amount of disturbance would accrue from similar construction activities in state sale areas and future federal lease sales. Even with the increase in benthic disturbance the regional impact on benthic fauna would remain negligible.

Entrainment of fish in dredging devices would pose a greater risk on state leases in nearshore waters, due to the higher concentration of anadromous and marine species during the summer. This impact is unlikely to occur given that most artificial islands in the areas close to shore would be constructed during the winter with gravel mined from onshore sources and trucked across ice roads to the construction site.

Causeways constructed as a result of these projects could also produce impacts on these marine biota. The possibility exists that causeways would be constructed as a result of Sale 71. Suggested sitings include Oliktok Point and Cape Halkett. Under the Sag Delta/Duck Island Unit project a causeway is proposed off of the Saganvirktok River Delta, and a causeway presently exists along the shoreline west of Prudhoe Bay.

The construction operations associated with these causeways would result in short-term localized impacts to fish, benthos and plankton as a result of increased turbidity and smothering of benthic habitat. The effects would be similar to those discussed aboved for gravel island construction. Once constructed the causeways could alter temperture/salinity regimes in areas around the causeways and disrupt local water circulation patterns. The resultant impacts on the biota are largely unknown at the present; however, fish have been shown to move around the Prudhoe Bay causeway without apparent impedance. Additionally, changes in the temperature/salinity regimes at this existing causeway have been within the range of natural flucuations. A concern would be that a causeway or several causeways could alter circulation patterns in a lagoon or other productive nearshore area, thus inhibiting the delivery of marine derived nutrients and migratory epibenthos into such a system. This could result in a loss of nearshore feeding and rearing habitat for anadromous fish. It is possible therefore, that causeways could result in a local, long-term impact to these resources. The magnitude of such an impact would be unknown; however, all that may result is a shifting of habitat use to another nearshore area. Regional, long-term impacts to these resources from causeways would therefore be negligible.

In conclusion the cumulative effects from these other projects on the fish, benthos, and plankton would be more pronounced than those from the proposal. However, only in the case of fish could these effects be measurable observed. Regional effects on plankton and benthos would remain negligible, even though benthic habitat disturbance from these cumulative projects would be greater than those produced by the proposal. Regional cumulative effects on anadromous fish could be moderate only in the unlikely event that a large oilspill contacted a critical overwintering area.

Effect of Additional Mitigating Measures: Adoption of the proposed stipulation requiring environmental surveys and subsequent protective measures would ensure that significant biological communities discovered at a later date would be protected from degradation of potential dredging impacts. Additionally, adoption of this measure would ensure consistency with Federal Stipulation No. 7 from sale BF, which places similar requirements on oil and gas lessees.

Involvement of the Biological Task Force would ensure the adequacy of survey designs and results in enforcement of this stipulation. The task force could provide the RSFO with expert technical advice in interpreting the results of the surveys and formulating additional or subsequent protective measures. The task force would also provide continuity between oil and gas lease sales and this and subsequent sand and gravel sales if any.

Unavoidable Adverse Effects: All of the effects mentioned above for dredging and island construction operations would be considered unavoidable. Mechanical agitation and disturbance of bottom substrate would result in impacts to the biota living on or in the substrate. Island construction would result in a loss of bottom habitat. Turbidity in the water column and subsequent deposition of sediment downstream would affect these biota in a number of ways. Entrainment of organisms in the dredging suction device would likely result in the mortality of all the organisms entrained.

The effects of turbidity and entrainment possibly could be minimized but not completely eliminated by using specialized design features in the dredging equipment. Use of submerged diffusor systems at the discharge point and/or silt curtains could minimize the effects on marine biota from turbidity. However, the use of these devices should be considered only on a case-by case basis.

c. Impacts on Marine and Coastal Birds: Several million migratory marine and coastal birds occur within or adjacent to the proposed sand and gravel lease sale area. Four species--red phalarope, oldsquaw, glaucous gull, and common eider--are among the most abundant species in the lease area and the most likely to have some interaction with OCS dredging activities. The numbers of marine and coastal birds occurring in the proposed lease area could be displaced and reduced somewhat by noise and movement from boat, dredge, and aircraft traffic associated with borrow mining and by habitat alteration from dredging activities and artificial island and causeway construction. This section briefly discusses the nature of effects of borrow dredging, borrow deposition, and supporting activities on marine and coastal birds and their food sources and habitats. The reader is directed to Section IV.B.2.b. for a more comprehensive discussion of borrow-mining effects on benthic and pelagic communities.

Effects of Noise and Other Disturbance: Human activities such as those associated with dredging and artificial island construction--especially air traffic--are known to disturb birds. Noise and movement of aircraft and boats could temporarily displace birds from offshore feeding areas and open-water areas during the spring. However, significant effects of disturbance on marine and coastal birds are more likely to occur in nearshore areas such as near barrier islands and lagoons. Borrow excavation and deposition, and support traffic near these areas could displace nesting birds and disturb others in important feeding and molting areas. Temporary or long-term displacement of nesting birds would reduce nesting success. Disturbance of molting and feeding birds could reduce migration fitness and contribute to migration mortality.

Effects of Dredging and Deposition on Habitat: Dredging and deposition of bottom sediments for artificial island construction would disrupt benthic habitat and remove and bury epibenthic prey (such as mysids) of marine and coastal birds. Such activities would also temporarily displace or reduce local pelagic prey (arctic cod) of seabirds at or adjacent to the sites of the activities. However, benthic disturbance levels, sedimentation, and turbidity would probably be as comparable in intensity and effects upon epibenthic biota as natural disturbances such as ice gouging, resuspension of sediments during storm surges, and excavation by strudel scour at river mouths during spring break up (U.S. Dept. of Commerce, NOAA, 1981). Effects of sedimentation and turbidity on pelagic and epibenthic prey species occurring near islands and causeways would be short-term with recruitment of epibenthic fauna from adjacent areas. Long-term or permanent loss of feeding habitat (prey habitat) would probably be confined to areas covered during placement of the islands themselves.

Dredging and artificial island construction may indirectly affect migratory birds through changes in currents, ice formation, ice movements, and ice-lead formations (see Sec. III.A.2.). Artificial islands would tend to anchor shorefast ice and perhaps extend the zone of winter shorefast ice seaward. This extension may change the formation of open-water areas used by migratory birds during the spring migration. The creation of additional shoreline habitat along the edges of the islands and causeways may attract shorebirds and other species and provide shelter on the leeward side of each island. However, human presence may limit bird use of these areas.

Site-Specific Impacts: During peak dredging and borrow deposition three to four artificial islands would be constructed at one time with a total of 24 islands constructed over the life of the project. Gravel dredging from the proposed lease sale area and deposition for three to four artificial islands would occur primarily during the open-water season during the peak of borrow mining activity. Likely sources of OCS gravel or borrow material are shown in Figure II-1. Marine and aircraft traffic in association with coastal dredging activity on the Colville and Sagavanirktok paleovalleys are more likely to disturb marine and coastal birds and disrupt local food sources than dredging and deposition of material in offshore areas. Such activities are likely to temporarily displace birds within a mile of the dredging and deposition sites and locally disrupt or reduce benthic and pelagic prey within several meters to several kilometers downstream of the sites (see Sec. IV.B.2.b.). In general, displacement of birds and reduction of food sources would occur locally near the dredging and deposition sites and be of temporary duration. Possible changes in ice-lead formation and chronic disturbance of birds due to increased human activity in the proposed lease area may change the distribution of birds or locally reduce some bird populations. However, human-tolerant species may be attracted to the artificial islands, and some local seasonal populations may increase.

Conclusion: Dredging and island construction could temporarily (one season) displace a few hundred to a thousand birds and tempoarily (one season) disrupt or remove some food sources within several meters to several kilometers downstream of the dredge sites and near the 24 islands to be constructed under the proposal. Lease area-wide impacts on marine and coastal birds are likely to be negligible.

Cumulative Effects: The additive effects of other ongoing and planned projects as well as the proposal on marine and coastal birds are discussed in this section. It should be mentioned that the probability of any or all of the planned and ongoing projects (listed below) reaching developmental stages is generally unknown and therefore great uncertainty exists in cumulative impact prediction.

National Petroleum Reserve-Alaska and Arctic National Wildlife Range: Oil and gas discovery, development, and production in the NPR-A and or ANWR could eliminate and alter an unknown amount of bird nesting, feeding, molting, and staging habitats on the arctic North Slope and disturb and displace an unknown number of birds. The level of impact will be determined by the amount and location of habitat affected and environmental protection measures enforced. These projects have greater potential effects on marine and coastal birds than offshore dredging and island construction alone.

Prudhoe Bay Oil Development: Further construction of drill pads, roads, and other facilities in the Prudhoe Bay-Kuparuk area would remove and alter additional habitat. The effects would probably not be great in comparison to

availible habitat. However, these projects are likely to have longer term effects than offshore dredging and artificial island construction on marine and coastal birds.

Ongoing and Proposed Federal OCS Oil and Gas Leasing: The joint Federal/State Beaufort Sea lease sale, Diapir Field sale 71, proposed Diapir sales 87 and 97, and Barrow Arch sales 85 and 109 are very likely to have cumulative effects on marine and coastal birds and their Beaufort and Chukchi Sea habitats throughout the region. Potential effects include mortalities, habitat contamination, temporary food source losses from oilspills, disturbance of nesting and feeding birds, and alteration of coastal habitats. Oilspills from these projects are likely to have greater effects on birds than dredging and island construction discussed in the proposal.

State of Alaska Offshore Oil and Gas Leasing: State proposed and ongoing offshore oil and gas exploration and production in the Prudhoe Bay, Harrison Bay, and Camden Bay coastal areas have the same potential effects as federal OCS activities. Potential oilspills from these OCS sales in addition to oilspills from federal OCS sales may cause substantial bird mortalities (in the thousands) if spills occur during the open-water season.

Canadian Oil and Gas Activities: Potential oilspills that may be associated with Canadian tankering, pipelines, and drill platforms during the open-water season or those still present during breakup of the ice may kill thousands of birds. Onshore activities associated with this project would also alter and disturb some bird nesting and feeding habitats. Dredging and island construction associated with this project is likely to have minor effects on birds.

Overall Extent of Cumulative Impacts on Marine and Coastal Birds: Cumulative activities related to the proposed sand and gravel lease sale, NPR-A and ANWR oil and gas exploration and possible development, further Prudhoe Bay oil development, ongoing and proposed federal and state OCS leasing, and Canadian oil and gas activities would subject marine and coastal birds and their summer habitats throughout the entire North American arctic to a variety of aggregate effects. Dredging and island construction associated with the proposal is likely to have a minor additive effect on marine and coastal birds. Potential oilspills from OCS activities could have the greatest certain short-term cumulative effects on birds with mortalities perhaps in the thousands to tens of thousands. Combined onshore oil and gas activities proposed and ongoing in the Prudhoe Bay, NPR-A, ANWR, and Canadian Mackenzie River delta could have long-term (5 years or more) effects on marine and coastal birds if several tundra nesting and feeding areas are destroyed or made unsuitable for successful reproduction. It is uncertain whether cumulative oil and gas exploration, development, and associated activities (such as dredging and island construction) all along the arctic coast and in the Beaufort Sea would have significant long-term effects on marine and coastal birds. The level of impact will be determined by the degree of industrial activity and the effectiveness and enforcement of mitigating measures.

Effect of Additional Mitigating Measures: Among the suggested mitigating measures, the orientation program, along with the guidelines established in the Information to Lessees on Bird and Marine Mammal Protection (Sec. II.B. l.c.), should help to minimize air, boat, and dredge traffic disturbance to

marine and coastal birds by informing the lessees and the public of this concern and by giving guidelines on how such a problem may be minimized. Although compliance with recommended air and boat traffic restrictions near bird colonies and nesting areas is voluntary, public awareness and compliance with U.S. Fish and Wildlife Service regulations and international treaties through use of the recommended guidelines in the Information to Lessees, could effectively eliminate most of this type of impact.

Unavoidable Adverse Impacts: The level of dredging and deposition associated with artificial island construction and associated marine and air traffic would unavoidably disturb some marine and coastal birds and disrupt and reduce some prey species habitat on and near the activity sites. However, considering existing environmental regulations, the level of unavoidable disturbance and the amount of habitat unavoidably altered are likely to be insignificant to regional arctic migratory bird species populations.

d. Impacts on Marine Mammals: Five species of nonendangered marine mammals--ringed, spotted, and bearded seals; polar bears; and beluga whales--commonly occur in the proposed lease sale area and are likely to have some interaction with OCS borrow mining activities. Noise and movement from boat, dredge, and aircraft support traffic and habitat alteration from mining activities and artificial island construction could affect marine mammals found in the proposed lease area. This section briefly discusses the nature of effects of borrow dredging and borrow deposition and supporting activities on marine mammals and on their food sources and habitats. The reader is directed to Section IV.B.2.a. for a more comprehensive discussion on the effects of dredging and deposition on the benthos and pelagic communities.

Effects of Noise and Other Disturbance: OCS borrow mining activities may disturb marine mammals through either airborn or underwater noise. Major sources of noise disturbance would be dredging; artificial island construction; and boat, barge, and aircraft support traffic. Behavior observations of beluga whales in the vicinity of active dredging and artificial island construction in the MacKenzie River estuary and the Canadian Beaufort Sea indicated that the whales react to such operations by avoiding the immediate area near the site (Fraker et al., 1978). Given an area of about 8,000 meters in diameter that may be influenced by industrial sounds, which animals can and do perceive (Ford, 1977, as cited by Fraker et al., 1978), actual observations of whale avoidance suggest that the whales alter their swimming patterns within about 2.4 kilometers (1.5 miles of stationary dredging operations. However, observations of bowhead whales within 5 kilometers (3.1 miles) of the Issungnak deep-water artificial island during dredging activities did not suggest that the animals were greatly disturbed by construction and dredging activities (Richardson et al., 1981). Beacause of the variable distribution of bowheads with the above area, it was impossible to statistically determine if there was significant avoidance of (or attraction to) the immediate construction site. There are some indications that whales may be more sensitive to underwater noise in shallow and confined water bodies than in deeper and open-water areas (Fraker, Greene, and Wursig, 1981). Thus recent scientific observations indicate that the noise from dredging and artificial island construction may alter marine mammal behavior patterns near the activity sites. However, the level of disturbance apparently depends on water depth, location, weather conditions, species of concern, and other environmental factors.

Noise from boat and barge traffic associated with dredging activities may disturb marine mammals by displacing animals from feeding and other habitat areas and by impeding migration and local movements. Observations of beluga whales encountering barge and boat traffic in the Mackenzie River estuary indicated that whales within 2.5 kilometers of the vessels were disturbed (Fraker et al., 1978). Fraker's observations of bowhead whales encountering boats producing noise indicated that the whales reacted to the boats at distances of several kilometers and that they moved away from boats approaching within 1 kilometer. However, this flight response seemed to be of brief duration, and the bowhead whales did not vacate the area.

Noise from aircraft as well as the movement of aircraft can disturb and displace pinnipeds and cetaceans (Johnson 1977; Salter, 1979; Burns and Harbor, 1977; Burns, 1980; Fraker et al., 1978; Richardson 1981). Aircraft, particularly helicopters, greatly disturbed colonial pinnipeds within 1 mile and cetaceans within 1,000 feet (Johnson, 1977; Fraker et al., 1978). Although aircraft traffic associated with dredging and island construction may temporarily displace marine mammals from coastal hauling out areas, ice flows, or offshore feeding areas during overflights, this disturbance is likely to be brief. Such disturbance could be minimized if support aircraft maintain a distance of 1.6 kilometers from known marine mammal concentration areas and avoid flying low (less than 460 m) over observed marine mammals (see Sec. II.B.1.c., Information to Lessees on Bird and Marine Mammal Protection).

Effects of Dredging and Deposition on Habitat: Borrow dredging and deposition for the construction of artificial islands and causeways would disrupt benthic habitat, remove and bury epibenthic prey organisms of marine mammals, and temporarily displace or reduce local pelagic prey (arctic cod) of seals at the sites of such activities and in adjacent areas. Benthic prey would be removed from the dredging sites, and others would be buried at the artificial island (deposition) sites. Other benthic fauna may be subject to smothering from sedimentation near deposition sites, and pelagic fauna such as arctic cod would be subject to suspended particulates and associated lethal or sublethal effects within the sediment plume area (see Sec. IV.B.2.b.). However, benthic disturbance levels and sedimentation and turbidity would probably be comparable in intensity and effects upon prey biota to natural disturbances such as ice gouging, resuspension of sediments during storm surges, and excavation by strudel scour during spring breakup (U.S. Dept. of Commerce, NOAA, 1981). Effects of sedimentation and turbidity on most prey species and lower trophic levels would be short-term, with recruitment of epibenthic fauna from adjacent areas similar to the recruitment that occurs after natural disturbances. Long-term loss of feeding habitat (prey habitat) would probably be confined to those areas covered during the placement of islands themselves.

Borrow mining and artificial island construction may affect marine mammals through changes in water current, ice formation, ice movement, and ice-lead formation (see Sec. III.A.2.). Artificial islands would tend to anchor shorefast ice and perhaps extend the zone of winter shorefast ice seaward. While extension of shorefast ice may have some favorable effects on ringed seals that use this zone, during the winter months industrial noise may prevent or limit the area's use. Dredging on offshore shoals and banks such as Weller Bank may slightly alter ice movements and ice-lead formation thereby possibly affecting the spring and fall migration corridors of marine mammals. However, the timing and location of spring and fall ice leads and the ice edge in the proposed lease area are highly variable, and marine mammals such as the beluga whale have adapted their movements to various ice and open-water conditions.

Site-Specific Impacts: Dredging and borrow deposition would occur primarily during the open-water season. During the peak of production activity, about three to four artificial islands would be constructed at one time. Likely sources of OCS borrow material are shown in Figure II-1.

Dredging activities and associated marine and air traffic around OCS borrow-material sources such as Weller Bank, Stamukhi Shoal, and the river paleovalleys would locally disturb marine mammals such as beluga whales and ringed and bearded seals in the vicinity. During the open-water season, dredging and island construction activities near the pack ice and remnant ice flows are more likely to disturb and temporarily displace marine mammals than nearshore activities. Dredging on Weller Bank, Stamukhi Shoal, and the outer portions of the Colville and Sagavanirktok paleovalleys could displace marine mammals within a few miles of the activities. These activities would remove or disrupt local benthic and pelagic prey organisms, thus changing marine mammal foraging areas. However, displacement of marine mammals from dredging sites is likely to be temporary for the duration of the activity. Disruption and removal of prey at the dredging sites would be temporary for most epibenthic prey, but infauna prey organisms may take 2-5 years to completely reestablish at dredge sites. However, considering the number of islands expected to be constructed and the acreage of benthic habitat available in the proposed lease area, the amount of benthic habitat and level of benthic community disruption would be low.

Conclusion: Dredging and island construction could temporarily (one season or less during dredging or construction) displace a few to several marine mammals within 2 to 3 kilometers of the activity sites and temporarily disrupt or remove some prey species within several meters to several kilometers down stream of the dredging sites and near the 24 island sites (minor local impacts). Lease area-wide impacts on marine mammals from the dredging and island construction alone, are likely to be negligible.

Cumulative Effects: Additive effects of other ongoing and planned projects as well as the proposal on marine mammals are discussed in this section. It should be mentioned that the probability of any or all of the planned projects (listed below) reaching development stages is generally unknown and therefore much uncertainty exists in cumulative impact prediction.

National Petroleum Reservé-Alaska and Arctic National Wildlife Range: Oil and gas discovery, development, and production in the NPR-A and ANWR would probably have little direct cumulative effect on most marine mammals unless oil tankering of upland hydrocarbons occurs. However, polar bears may be an exception. Oil and gas activities near polar bear maternity dens on land may displace female bears leading to perhaps reduced reproductive success on the arctic North Slope. However, such disturbance may be reduced by mitigating measures.

Prudhoe Bay Oil Development: Increased construction and other development activities in the Prudhoe Bay area may increase local disturbance of denning polar bears. Other marine mammals are not likely to be affected by this project. However, the waterflood project could locally alter ringed seal food source availability but this effect is likely to be small.

Ongoing and Proposed Federal OCS Oil and Gas Leasing: The joint Federal/ State Beafort Sea lease sale, Diapir Field sale 71, proposed Diapir sales 87 and 97, and Barrow Arch sales 85 and 109 are likely to have some cumulative effects on marine mammals particularly ringed seals and polar bears. If oilspills occur some seals could be contaminated. The loss of unknown local numbers of ringed seal pups may occur in contaminated ice habitats. Seismic activities on stable ice habitat are suspected to disturb denning female ringed seals prior to and during the pupping season. If such an effect does occur the cumulative seismic activities associated with OCS leasing may significantly reduce ringed seal productivity (for example by 10% or more). Dredging and island construction during the open-water period would contribute little to the above cumulative disturbance effects.

State of Alaska Offshore Oil and Gas Leasing: Ongoing and proposed state offshore oil and gas exploration and production in the Harrison Bay, Prudhoe Bay, and Camden Bay coastal areas have the same potential cumulative effects on marine mammals as federal OCS activities. Oilspills may impact ringed seals and polar bears especially the young in local areas. Additional seismic activities could contribute to ringed seal disturbance in these areas.

Canadian Oil and Gas Activities: Potential oilspills that may be associated with Canadian tankering, pipelines, and drill platforms could contaminate some ringed seals, bearded seals, and polar bears and perhaps reduce local populations. Seismic activities may also displace seals and cetaceans from local habitat areas. The dredging and island construction associated with Canadian oil and gas activities compared with cumulative effects discussed above is likely to be small.

Overall Extent of Cumulative Impacts on Marine Mammals: Cumulative activities related to ongoing and proposed state and federal OCS oil and gas exploration and development and Canadian oil and gas activities would subject marine mammal populations all along the North American Arctic Coast to the aggregate of different disturbances and potential oilspills. Onshore oil and gas exploration and possible development on NPR-A and ANWR may contributed to disturbance of denning polar bears while cumulative winter seismic activities associated with OCS exploration may significantly reduce ringed seal productivity (for example by 10% or more). Oilspills could reduce local ringed seal populations near the spill sites while increased air and boat traffic all along the Beaufort Sea Coast may temporarily displace marine mammals from important habitat areas. Dredging and island construction discussed under the proposal is likely to contribute little to the overall impact of oil and gas development on marine mammals. It is uncertain whether cumulative oil and gas exploration, and development and associated activities (such as dredging and island construction) all along the arctic coast and in the Beaufort Sea would have significant long-term effects on marine mammals. The level of impact will be determined by the degree of industrial activity and associated development and the effectiveness and enforcement of environmental regulations.

Effect of Additional Mitigating Measures: Among the suggested mitigating measures, the orientation program, and the guidelines established in the Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.B.-

l.c.), should help to minimize air, boat, and dredge traffic disturbance of marine mammals by informing the lessees and the public of this concern and by giving guidelines on how such a problem may be minimized. Although compliance with recommended air and boat traffic restrictions near haulout areas and marine mammal concentrations is strictly voluntary, public awareness and compliance with the Marine Mammal Protection Act and U.S. Fish and Wildlife Service regulations through use of the guidelines in the Information to Lessees, could effectively eliminate most of this type of disturbance.

Unavoidable Adverse Impacts: Dredging, island construction, and associated marine and air traffic would unavoidably disturb some marine mammals. These activities would also disrupt and eliminate the benthic habitat of some prey species on and near the activity sites. However, the levels of unavoidable disturbance and the amount of marine habitat unavoidably altered by the proposal are likely to be insignificant to regional marine mammal populations.

e. Impacts on Endangered Species: Major impact-producing agents which could potentially affect endangered whales in the proposed lease sale area from dredging and gravel island construction activities include: physical barriers, turbidity, and noise and disturbance. A brief review of knowledge regarding types of effects (including most likely effects) and the expected significance of such effects as related to proposed sand and gravel mining activities are discussed in subsections headed "Review of Potential Effects" and "Most Likely Potential Effects," respectively. Additional detailed information on the effects of major impact-producing agents which could potentially affect endangered whales can be found in both the sale 71 FEIS and the recent Biological Assessment for Endangered Whales of the Arctic Region With Respect to Hard Minerals Leasing (Dubsky, 1982), and in OCS Technical Paper No. 9 (Cowles et al., 1981).

Endangered Species Consultation: As part of the requirements under Section 7 of the Endangered Species Act of 1973, as amended, potential factors which may affect endangered species are assessed through appropriate interagency consultation. A request to initiate formal consultation was sent to the National Marine Fisheries Service (NMFS) on September 30, 1982. This request was submitted along with a "Biological Assessment for Endangered Whales of the Arctic Region with Respect to Hard Minerals Leasing" which, in part, determined that gray and bowhead whales were the only endangered species likely to be found in or near the proposed lease sale area. To date, a biological opinion on the effects of sand and gravel leasing activities on endangered cetaceans has not been received from NMFS. Therefore, the anticipated final opinion will not be available in time for publication of this document.

There are no endangered species under the jurisdiction of the U.S. Fish and and Wildlife Service (FWS) in the arctic region that may be affected by offshore sand and gravel activities. Therefore, a decision was made not to consult with FWS with respect to sand and gravel leasing in the Beaufort Sea. This decision was based upon the recent biological opinion on proposed OCS oil and gas leasing and exploration in the arctic submitted by the FWS on November 9, 1981. This opinion stated in part that "gravel operations, if conducted offshore, would pose no threat" to the arctic peregrine falcon. Other endangered species in the arctic under FWS jurisdiction will not be affected by proposed sand and gravel activities.

Review of Potential Effects

A. Physical Barriers: Some interaction between whale movements and dredging, barging, and dumping of fill associated with the proposed action must be anticipated. However, temporary artificial islands for exploration, once in place, are not likely to interfere with gray and bowhead whale migration or other behavior. Observations in other geographic areas indicate that behavior of gray whales is not significantly disrupted by offshore petroleum industry activities (including dredging and associated gravel island construction activities). Geraci and St. Aubin (1974) concluded that species such as the gray whale seem to coexist well with human activities and most animals become accustomed to low level background noise such as that associated with petroleum activities.

There is a very small possibility that the bowhead's behavior may make them vulnerable to potential collisions with vessels. The anticipated increase in levels of boat support are such that it is extremely unlikely that collisions would lead to any significant population-level responses. The relatively small number of dredging facilities and artificial islands, their expected size, and potential continuous fill causeways that may be associated with expected borrow activities are unlikely to have a significant effect on bowhead ability to physically move through these areas. Fraker et al. (1981) frequently observed bowheads near construction sites during the summer months. Several bowheads observed during aerial surveys were quite close to gravel island construction areas. Although preliminary data showed uneven and variable distribution within the surveyed area, the results did show that bowheads commonly did occur near the construction site.

B. Turbidity: The short-term, site-specific increases in turbidity expected from dredging and island construction is not expected to adversely impact endangered whales or habitats within the proposed lease area. Sediments introduced into the water column by dredging operations associated with construction of artificial islands and causeways would be less than that which occurs naturally during spring break-up or when storms resuspend bottom sediments (Lowry and Frost, 1981).

It is expected that dredging of individual sites would create a mild local turbidity plume and clamshelling would create a more severe one. Turbidity plumes at the construction site evidently would be minimal for bargedumping, but more intense if fill were placed by clamshell. This turbidity plume is expected to be comparable in intensity to turbidity caused by natural phenomena associated with arctic conditions (storm waves, ice gouging, strudel scour, direct influx of muddy river water). Since these natural phenomena have no apparent adverse impacts on bowhead or gray whales, local turbidity plumes associated with dredging are not expected to result in adverse impact to these animals.

A possible but remote indirect effect on endangered whales within the proposed lease sale area is the reduction of productivity because of siltation in the water from dredging and artificial island construction. Patches of gravel on the sea bottom provide substrate for epifauna, which may in turn be a food source for animals (including whales) higher in the food chain. However, the Beaufort Sea is not an important feeding area for gray whales--most gray whale feeding activity takes place in the southern Chukchi Sea and Bering Strait region.

Bowhead whales feed little, if at all, during spring migration (NARL,1980). However, the eastern Beaufort Sea (Canada) constitutes the main part of the summer range of the western Arctic population and is believed to be a major feeding area (Fraker and Bockstoce, 1980). The importance of the eastern Beaufort Sea to bowheads as a summer feeding ground is supported by available data on the regions primary productivity (Griffiths, 1981) and observations of feeding behavior (Wursig et al., 1981). Also, the bowheads summer feeding range appears to extend westward into the Alaskan Beaufort Sea in late summer and early fall (Griffiths, 1981) during the westward migration period. Ljungblad et al., (1982) reported observation of suspected feeding behavior east of Barter Island, near Demarcation Bay--Beaufort Lagoon during mid- to late September. Ljungblad also observed this same type of behavior within the BF area. Therefore, it may be surmised that bowhead feeding activity in the Alaskan Beaufort Sea may be effected by dredging and artificial island construction activities. A reduction in productivity of bowhead food sources in site-specific areas (borrow pits, gravel islands) may occur. The extent of the effects on the bowhead feeding activities, however, is unknown but believed to be negligible due to the relatively small areas disturbed by dredging and/or filling as compared to the vast lease sale area.

C. Noise and Disturbance: Noise is believed to be the by-product of normal industrial operations that may be most likely to affect whales significantly. Probable increases in noise and disturbance from vessels, aircraft, and dredging activity can be anticipated from the proposed action. Some interaction between whale movements and the noise and disturbance produced by the anticipated increases in vessels and barging and dumping of fill may be expected. It is anticipated that industry will probably lengthen the barging season through the use of ice breakers during early summer and late autumn so water traffic will be active during seasons that currently are relatively quiet. In addition, the nature and distribution of sand and gravel resources is different in sale 71 area from those in the BF area. Exploration in sale 71 area may require movement of considerable quantities of fill for long distances. Thus, as exploration extends into the more deeper areas, obtaining necessary fill will probably result in a great deal more water traffic.

Field observations of cetacean responses to noise and disturbance provide some index of sensitivity of whales. For example, with respect to the gray whale in southern California, Dohl et al. (1978) concluded that "the reasons for this apparent increase in utilization of offshore waters are unknown, but might be the result of increased human activity in the Bight, increased gray whale numbers, or some combination of both factors." There are no confirmed reports or documented evidence of this species actively and consistently avoiding exploratory or production platforms, helicopters, seismic operations, or other OCS activity; in fact, numbers of gray whales nearshore along the California coast have remained relatively stable in spite of human activities, including oil exploration (personal communication, T. P. Dohl, University of California at Santa Cruz, 1980). Reeves (1977) identified potential conflicts of disturbance sources and breeding gray whales in Baja, California. Subsequently, Swartz and Jones (1978) reported that although boat traffic in the Laguna San Ignacio (a gray whale breeding habitat) increased 30 percent over the previous season, boat activity did not affect large-scale movements or distribution of gray whales. Although localized avoidance behaviors were observed, gray whales became accustomed to boat traffic as the period of exposure to such disturbance increased (Swartz and Jones, 1978).

Some interaction between bowhead whale movements and vessel activity must be anticipated. Preliminary field experiments on bowhead whales showed statistically significant differences in behavioral parameters as a result of nearby boat activity, including decreased time spent at surface, decreased number of blows per surfacing, increased spreading out of grouped animals, and significant changes in directional orientation (Fraker et al., 1981). However, flight responses seemed to be of brief duration. Bowhead whales tended to move away from boats which approached within 1 kilometer (0.62 mi) and were observed reacting to boats at distances as great as 3.7 kilometers (2.3 mi). Bowheads overflown by fixed-wing research aircraft seemed more sensitive than certain other species. Altitudes of about 450 meters were maintained by Fraker et al. (1981) to minimize disturbance of bowheads. Diving responses to aircraft at lower altitudes (observed by Fraker et al., 1981) may have been associated with factors other than noise alone, although the latter workers recorded relatively large amounts of noise entering the water from aircraft. Observations of bowheads in the vicinity of an artificial island construction in the Canadian Beaufort were made by Fraker et al. (1981). Although the sample size was judged inadequate, no discernable abnormal behavior was observed. Some animals were as close as 0.8 kilometers (0.5 mi) to the Issungnak construction site in Canada, which included the presence of operating dredges. According to Fraker and Richardson (1980), sounds from dredges were well above ambient levels, and almost certainly audible to bowheads, out to at least 7.4 kilometers. In addition, according to Fraker et al. (1981), "the presence of construction operation at Issungnak in the summers of 1978 through 1980 has, to date, produced no discernable decline in utilization of the area by bowheads."

Loud noise is not unusual in the marine environment. Baleen whales produce low frequency sounds (usually less than 1000 Hz) for communication. Some species of baleen whales may vocalize at sound levels exceeding that of natural ice related noise. Low frequency sounds most commonly produced and likely to originate from dredging activities, are much less physically destructive. Although no complete data exists on the effects of dredging noise, waterborne sounds from dredging operations are considered similar to those produced by boat traffic (Ford, 1977). Thus, physical adverse direct effects from low frequency sounds produced by dredging activities on endangered cetaceans within the proposed lease area are unlikely. However, indirect and cumulative effects on endangered gray and bowhead whales from dredging activities remain uncertain.

MOST LIKELY POTENTIAL EFFECTS

A. Gray Whale: Interaction between potential impact producing agents (physical barriers, turbidity, noise, and disturbance) and this species from the expected activity within the proposed lease sale area is unlikely. Available data and observations discussed herein suggests that if any species of whale is tolerant of human noise and activity, it would be the gray whale. This animal has demonstrated a certain degree of tolerance to boat activity during its occupancy of breeding lagoons (which would probably be the most sensitive period in its life cycle). Moreover, their summer distribution in the Alaskan Beaufort Sea near the proposed sand and gravel lease sale area is comprised of only a relatively small segment of the population, restricted primarily in the western Beaufort Sea region. Therefore, interaction between potential impact-producing agents and this species from the proposed activity within the proposed lease sale area is very unlikely.

Findings such as these do not belie the fact that gray whales might possibly react to certain types of acute and localized disturbances associated with dredging activities (increased vessel traffic, increased low frequency noises). However, the existing information base suggests strongly that the types and levels of noise and disturbance associated with dredging activities in arctic environments will not create a significant adverse impact on this population. Short-lived and local impacts, however, might be expected in the western Beaufort Sea region specific to gray whale interaction with proposed sand and gravel leasing areas.

B. Bowhead Whale: The knowledge that the entire bowhead whale population passes through or near the proposed lease sale area, the migration occurs in a relatively constrained corridor in certain nearshore areas on the whales westward migration, and that even an apparently limited impact may be of relatively great consequence to a species as depleted as the bowhead, leads to the conclusion that the species may be affected by activities associated with sand and gravel leasing.

The most likely potential effects due to the proposed action include the uncertain amount of but anticipated increase in noise and disturbance from increased vessel, dredging and aircraft traffic associated with the proposed action. As discussed previously, potential effects due to physical barriers (gravel islands, barges, ships), low frequency dredging noises, and increased turbidity are not expected to adversely effect the bowhead whale population within the proposed lease sale area.

The most probable significant consequence of sand and gravel dredging within the proposed lease sale area will be the increased amount of noise associated with air and vessel traffic (including moving dredges).

1. Effects of Aircraft: Responses of bowheads to aircraft may be attributed to sound that is transmitted from the air into the water, and from the physical presence of the aircraft. Previous information on reaction of whales to aircraft is limited (Fraker et. al., 1982). Recent data from Fraker (1982) suggests that bowheads on the Beaufort Sea summering grounds did not appear to react to a survey aircraft (twin otter) flown at 305 meters above sea level, but whales that were being circled and photographed responded in all cases by diving (LGL Ltd., unpubl. data). During recent surveys in the Canadian Arctic (Davis and Koshi, 1980), bowheads overflown by a twin otter at 90 meters almost always dove, whereas those overflown or circled at 305 meters often showed little or no discernable response, but systematic data was not available. Bowheads appeared less likely to dive when in pack ice or on summering grounds then when actively migrating, but again no systematic data are available. Although Fraker did not analyze recent data in any rigorous way, the correllation between the presence of aircraft circling overhead at 305 meters and the whales diving, was clear to the observers. Ljungblad et al. (1980) reported that all bowheads overflown by aircraft at altitude of 91-152 meters dove immediately.

The above data suggests that bowheads may be sensitive to aircraft noise. Therefore, based upon the above information and that previously discussed in the Biological Assessment for Endangered Whales of the Arctic Region with Respect to Hard Minerals Leasing (Dubsky, 1982) it can be concluded that disturbance associated with increased aircraft activity associated with the proposed action may affect bowhead whales as they migrate through the proposed lease sale area during the fall migration period. The extent of this disturbance on the population as a whole, however, is unknown but believed to be minimal.

2. Effects of Vessels: Vessel activity (boats, barges, possibly aircushion vehicles, icebreakers) is expected to increase with the advent of the sale of sand and gravel from the Beaufort Sea. The increase in vessel activities, and associated noise and disturbance, pose the most likely potential impact to bowhead whales within the proposed lease sale areas.

It is generally agreed that underwater sound has the greatest potential for effecting whales (Fraker et. al., 1982). Boats and ships are the most widespread source of potential disturbance to which bowheads are exposed on their summering grounds in the eastern Beaufort Sea (Fraker et al., 1982). Fraker et al. (1982) suggested that bowheads showed considerable tolerance of ongoing noise from boats, and he surmised that bowheads would habituate to the continuous sound of a boats idling engines. However, information gathered to date indicates that bowheads respond to boats (especially moving operating vessels) even when they are at a considerable distance. Recent experiments (Fraker et al. 1982) in the Canadian Beaufort Sea with the "Imperial Adgo" have increased our knowledge of the effects of vessel noises on bowhead whales. As soon as the engines of the "Imperial Adgo" were started, whales at a distance of 3.7 kilometers responded even though the boat remained stationary with the propellers disengaged. The mean surface time per surfacing became stronger and its variability increased. The large number of observations made at close range from the boat itself indicated that the boat had no major effect while it remained silent, even when it was within 900 meters. However, when its engines were idling, the whales tended to orient away. The investigators surmised that it is possible that the response of the whales to the noise of idling engines resulted from the novelty of the situation, i.e., the sudden onset of the noise, after the boat had remained silent for sometime.

In summary, on at least some occasions, bowheads were found to react to boats at distances of several kilometers when the boats are producing noise. When a boat approaches to within 1 kilometer, and sometimes to within 3 kilometers, the whales move away from the boat. However, the authors found no evidence that bowheads vacated any area where they had been disturbed by a boat; the flight response seemed to be of brief duration. Whether frequent or continuous boat disturbance would ultimately cause bowheads to vacate an area or would lower their reproductive fitness is unknown (Fraker et al. 1982).

It can be surmised from the above information that increased vessel noises associated with the proposed action is likely to affect a few bowhead whales during the fall migration period. Effects on the population however, are unknown but believed to be negligible. Recent observations on noise and disturbance are consistent with the idea that bowheads are sensitive to certain types of disturbance. Additional evidence suggests that bowheads show considerable tolerance of ongoing noise from boats and may habituate to continous boat sounds (idling) but respond somewhat to boat noises when they are at a considerable distance. Therefore, the overall effects from ship noise and disturbance may result in behavioral changes, either immediate or long-term. The ultimate long-term effect of disturbance may be abandonment of a particular area, and possibly reduced productivity and population size. However, long-term behavioral effects from increases in noise and disturbance from vessel activities are unknown. Short-term behavioral effects in the vicinity of the proposed sale area from the increases in noise and disturbance can be expected. These effects (most probably a brief flight response) however, would not preclude a successful migration, although localized changes in migratory routes could be possible.

3. Significance of Potential Effects: Based upon this review, the recent Biological Assessment for the Arctic with respect to Hard Minerals Leasing (Dubsky, 1982), and Biological Opinions for both the Arctic region and BF areas, it can be concluded that a few of the factors associated with sand and gravel sales may affect some bowhead whales during their westward migration period through the proposed sale area. The most likely include certain shortterm behavioral changes induced by noise and disturbance sources associated with anticipated increases in aircraft and vessel traffic (e.g., brief flight response, changes in surfacing characteristics, changes in directional orientation). However, these short-term behavioral effects in the vicinity of the proposed leasing areas would not normally preclude a successful migration, although localized changes in migration routes could occur. Whether frequent or continuous boat and vessel disturbance would ultimately cause bowheads to vacate an area or reduce productivity and population size is unknown. In addition, it may be surmised that bowhead feeding activity in the Alaskan Beaufort Sea may be affected by activities associated with sand and gravel leasing (vessel and aircraft traffic dredging and gravel island construction) activities. A reduction in productivity of bowhead food sources in site-specific areas (borrow pits, gravel islands) may occur. The extent of the effects on the feeding activities of the overall population, is unknown but believed to be minimal.

Conclusions:

Gray Whale: Gray whales are unlikely to be adversely affected by activities associated with the proposal.

Bowhead Whale: A few bowhead whales are likely to be affected by air and vessel traffic during the fall migration period. However, impacts on the overall population are most likely to be minor and short-term in duration. Behavioral effects such as brief flight response and/or temporary changes in migration patterns can be expected in the immediate vicinity of activity associated with the proposed sand and gravel lease sale area. These shortterm effects, however, are not expected to preclude a successful migration.

Cumulative Effects: Other major projects have been or may be initiated in the arctic region and may cumulatively affect whales due to impacts in other regions. These include petroleum exploration in the National Petroleum Reserve of Alaska, Prudhoe Bay oil development under the State of Alaska leasing, State of Alaska and federal oil and gas leasing on the continental shelf, Arctic Slope Regional Corporation oil and gas leasing, non-arctic federal offshore leasing activity, and Canadian oil and gas offshore leasing activity. These cumulative activities have the potential for subjecting whales of the Beaufort Sea to a variety of aggregate effects. However, the aggregate total impacts of these projects which have been identified as potential factors affecting whales cannot be assessed clearly at this time. The levels of proposed sand and gravel leasing activities discussed previously would only contribute a very minor portion of the total cumulative impacts which could result from all the energy development projects discussed above. Therefore, the incremental impact of sand and gravel leasing activities is likely to be insignificant when compared to certain existing activity (e.g., Canadian exploration and development, to include seismic activity and tankering traffic).

Effect of Additional Mitigating Measures: Information to Lessees on Bird and Marine Mammal Protection may reduce risks to endangered cetaceans below those discussed previously. Paragraphs three and four of the proposed Information to Lessees suggest means of avoiding vessel, aircraft, and dredging disturbance to migratory bowhead whales. This Information to Lessees may eliminate certain localized impacts (brief flight response and/or temporary changes in migration patterns) on individual cetaceans or small population segments. However, such reduction of risk probably would contribute only a minor overall benefit to local endangered cetacean populations.

The effectiveness of this measure depends largely on the degree of voluntary compliance which would be demonstrated by future lessees or their contractors. Also, because the location and time of occurrence of bowhead whales cannot be predicted with high confidence, and because the whales are non-stationary, site-specific Information to Lessees cannot be considered as likely to minimize disturbance to bowhead whales as it may for other species. Accordingly, additional measures (such as Stipulations, Information to Lessees, or Operating Orders) could be promulgated as provided under Section 3(5) of the OCS Lands Act of 1978 for the purpose of prevention of damage to the environment. Enforcement of other regulations (or impact-avoiding measures) promulgated or adopted under other existing laws (e.g., the Marine Mammal Protection Act of 1972 or the Endangered Species Act of 1973) by DOI or other agencies may provide comparable or more effective protection of bowhead whales from behavioral disturbance associated with sand and gravel mining activities.

Unavoidable Adverse Effects: The magnitude of unavoidable impacts on endangered whales is unknown but perceived to be minimal. Uncontrolled noise and other forms of disturbance associated with proposed sand and gravel mining activities may cause temporary behavioral responses or long-term change in species distribution and productivity. Such disturbance-related impacts would be most likely to occur to bowhead whales during periods when they are migrating through the proposed sale area (September-October).

3. Impacts on Water Quality: Dredging introduces particulate matter into the marine environment by disturbing the bottom sediments, by continually discharging a solid/water slurry from a pipeline located at or beneath the surface, and by intermittently dumping large volumes of dredged material. More than 90 percent of the discharged material descends rapidly to the seafloor while the remainder composed of the fine-grained silt and clay particles will enter the suspended transport system where movement by waves and currents will be the same as for naturally suspended sediment particles. The increase in the concentration of sediment particles in the water column

that occurs during dredging operations is expected to affect a relatively small area for a short period of time. Dispersion and settling reduces the concentration of particulate matter downstream from any discharge and sediment disturbance sites.

Turbidity is the muddy or cloudy appearance that the suspended particles give to the water masses. This makes the water muddy (decreased water quality). Muddy water of itself is not an adverse impact. River discharge, resuspended bottom sediments from storm activity, ice movement, spring break-up and other forms of natural phenomena also make the Beaufort Sea muddy. Adverse impacts from the decrease in water quality are expressed in the stresses this muddy water causes on biological populations of the area. Section IV.B.2. discusses in detail these impacts on the non-human life forms that inhabit the area. Section IV.B.1. discusses how these effects on non-human creatures affect the human population of the North Slope.

Initially, the concentration of suspended particulate matter in the water column depends on the grain-size composition of sediments being dredged and the amount of mechanical agitation. Deposits with relatively large numbers of clay- and fine, silt-size particles, such as a fine-grained overburden, contain potentially more suspendable material than deposits composed of clean, coarser-grained sediments. Northern Technical Services (1981) note that in the dredging of suitable fill material the concentration of suspended particles would probably be less than 200 mg/l for a 2.4 meter (8 ft) diameter suction cutterhead rotating at speeds up to 30 RPM. Increasing the rotational speed of the cutterhead increases the turbulence in the water column in the vicinity of the head and increases the concentration of suspended sediments.

In hydraulic dredging operations, the sediment water slurry that flows into the intake pipe typically contains 15 to 20 percent solids and 80 to 85 percent water. The slurry may be discharged directly into the water column or into the hoppers of dump barges or hopper dredges; slurry overflow during hopper filling and dumping of the hoppers eventually discharges the dredged slurry sediments into the water column. The choice of disposal method depends mainly upon the proximity of the dredge site to the disposal site and also on the accuracy required in the placement of the dredged material. Regardless of the method used, the eventual discharge of dredged material into the water column creates an effluent of turbid water that extends downstream from the outflow for a distance of 1 to 3 kilometers (0.6-1.9 miles).

The size, duration, and amount of turbidity depends on the grain-size composition of the discharge, the rate and duration of the discharge, the turbulence in the water colum, and the current regime.

The discharge of a sediment/water slurry into dump barges or hopper dredges creates an overflow. Previous experiences (NORTEC, 1981) indicate that in dredging sand and gravel 90 to 95 percent of the solids in the overflow would fall rapidly to the seafloor and upon encountering the bottom would behave as a density flow and spread outward. The concentration of suspended particles near the overflow would likely be in the order of 10,000 to 20,000 mg/l but could be as high as 100,000 mg/l. In the event that material from a fine-grained deposit, such as an overburden layer, is discharged onto a barge, the overflow may generate suspensate concentrations as high as 370,000 to 500,000 mg/l in the water near the overflow. (500,000 mg/l is approximately equal to

1.03 pounds of solids in a one quart solid/water mixture.) However, concentrations of these magnitudes would be present only during the discharge. Dispersion and settling of the particles downstream from the outflow discharge would reduce this concentration once discharging ceased.

The vast majority of fine-grained material in the discharge that descends rapidly to the seafloor and flows radially away from the impact area as a low density mud flow forms a mound of fluid mud overlying the existing sediments (Barnard, 1978). The lateral extent of this mound is difficult to estimate but is determined at least in part by the bathymetry. As the mud layer flows upslope it decelerates but the layer will continue to flow down a slope as low as 1 or 2 degrees. The upper part of the fluid mud layer grades into the overlying turbid water and the boundary between these two probably occurs within a layer where the particulate concentration increases from 5,000 to 200,000 mg/l. Some of the material falling through the turbid water becomes incorporated in the fluid mud layer. In this layer the concentration of material increases rapidly with depth and at the base, it may be as high as 500,000 mg/l. Those environmental and operational factors which cause the particulate matter in the water column to disperse also tend to increase the lateral extent of the fluid mud layer and to decrease its thickness. Consolidation of the fluid mud takes a relatively long period of time and some of the material will be lost due to resuspension by currents or waves. The amount of material lost depends upon the magnitude and duration of the forces that cause the resuspension.

In a study for a proposed sand and gravel dredging operation at a site northwest of Prudhoe Bay, NORTEC (1981) estimated that for the anticipated range of ambient currents, 5 to 15 cm/sec (0.11-0.33 mph), the maximum suspended concentrations near the discharge were estimated to be on the order of 100 to 200 mg/l and confined to a wake approximately 50 meters (164 ft) wide. One thousand meters (3,280 ft) further downstream the concentration would likely range from 20 to 70 mg/l and the wake would be approximately 230 meters (755 ft) wide.

Experiences with actual dredging operations in other areas show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance downstream (1-3 kilometers) from the discharge. In the dredging operations associated with artificial island construction and harbor improvement in the Canadian Beaufort Sea, the turbidity plumes tended to disappear shortly after dredging ceased and generally, they were not spatially extensive (Pessah, 1982); sand was the predominate material dredged.

The discharge of dredged materials through a pipeline emits a continuous solid/water slurry. The concentration of sediment particles in the water column that was discussed previously for the overflow from a barge loading operation indicates the range of particulate matter that might also be expected for a pipeline discharging directly into the water. The sediment laden water acts as a density current which carries with it a relatively large portion of fine-grained particles. The particles that remain in suspension, about 1-3 percent of the total sediment discharge, create a column of turbid water which is continuously supplied with particulate matter from the discharge. The lateral movement depends on existing currents. The turbid water will dissipate through the action of natural forces after the discharge has ceased and the turbulence caused by the passage of the sediment mass has subsided. The factors affecting the physical properties and spatial and temporal characteristics of the turbid water have been discussed previously.

Dumping from barges or hoppers intermittently introduces a large volume (up to several thousand cubic meters) of sediment into the water column in a very short period of time. This action also creates a density current, but it is generated by a larger initial mass and is short-lived when compared to the density currents associated with a continuous discharge operation. The factors affecting turbidity have been discussed previously.

Summary: The major effect that dredging operations will have on the water quality in the lease sale area will be to increase the turbidity of the water in the vicinity of dredging and discharging activities. Depending on the particle size, composition of the material being dredged, and the type of operation, the increase in the concentration of suspended particulate matter in the water column could range from (1) a low of several hundred mg/l for the hydraulic discharge of a clean sand or gravel through (2) intermediate values of several tens of thousands of mg/l for the overflow of muddy sand and gravel discharged into a dump barge to (3) a high of hundreds of thousands of mg/l in the case of an overflow from a muddy overburden discharged into a dump barge. After dredging operations cease, most of the water column in the affected area will have turbidity in the several hundred mg/l range. The visual turbidity at and near the surface will usually disappear within several hours after discharging stops, but the subsurface turbidity may persist for several days. Water masses with particulate matter concentrations in the intermediate and high ranges descend rapidly to the bottom and form a fluid mud layer. Potentially, this layer has a relatively long residence time (up to several months), but after the seafloor disturbances caused by late summer and early fall storms, winter sea ice, and spring breakup conditions, there is very little chance that the fluid mud layer will survive the interval between the open seasons in the sale area.

Conclusion: The water quality element affected is turbidity levels. Long-term impacts on the regional water quality (increased turbidity) as a result of the proposed action are negligible. However, short-term local impacts will vary because turbidity levels may increase by several hundreds to hundreds of thousands of mg/l of suspended solids for a very short period.

Cumulative Effects: An evaluation of the present and future drilling, production, and transportation activities associated with oil and gas leasing of the existing sales BF (USDI, 1979) and 71 (USDI, 1982) and proposed Diapir Field sales 87 and 97 indicates that there would be an increased risk of water quality degradation due to discharge of drilling muds or formation waters or the accidental discharge of oil. However, proposed discharges of all types of contaminants from offshore OCS exploration and production operations are the subject of the National Pollution Discharge Elimination System permitting program mandated under the Clean Water Act. Under this program, EPA establishes discharge limitations for various contaminants that will not interfere with beneficial uses of the marine waters. In addition, there are environmental mechanisms for the dispersal of contaminants and these include (1) waves, (2) currents associated with the wind-driven circulation and large-scale shelf circulation, and (3) the freezing of sea water, which entraps contaminants, and sea ice movement. The intentional discharge of drilling fluids or formation waters into the marine environment causes an immediate local adverse impact on the water quality in the vicinity of the discharge but the effect is short-term because dispersion in the open water typically dilutes the concentration of the components of the substances to background levels within a few hundred meters of the discharge; an accidental discharge of these substances would have the same result. However, the accidental discharge of oil into the environment may cause an adverse regional impact on the water quality if the volume of oil spilled is measured in terms of hundreds or thousands of barrels. On the other hand, if only a small volume of oil were spilled (a few tens of barrels or less), the impact would be local. In either case the dispersal mechanisms laterally transport the dissolved and undissolved hydrocarbons not removed during cleanup operations from the discharge site so that the adverse impacts are short-term. Thus, cumulative long-term impacts on the regional water quality are very unlikely.

Effect of Additional Mitigating Measures: "Protection of Biological Resources" and "Protection of Cultural Resources" are the two suggested mitigating measures that could directly affect the water quality. If there were a need to impose the provisions of the measures, dredging operations may be required to relocate which would adversely affect the water quality at the alternate site. Changes in the water quality resulting from a relocation would be affected by possible differences in (1) the composition of the material to be dredged, (2) the equipment or methods used to dredge or discharge material, and (3) the current regime. Thus the effects of the mitigating measures would most likely be site-specific and would probably change the overall impact of dredging operations on the water quality within the proposed sale area only slightly.

Unavoidable Adverse Effects: The only unavoidable adverse effect on water quality anticipated from the proposed action is the impact of introducing relatively large quantities of particulate matter into the water column in the vicinity of dredging and discharging activities. When dredging operations cease, the effects that the particulate matter has on the water quality dissipates within a relatively short period of time.

C. Alternative II - No Sale

About 24 percent of the proposed sand and gravel lease sale area has already been leased for oil and gas exploration and development. The no sale alternative would restrict mining and deposition activities to those leased areas illustrated in Figure II-3. This alternative would only eliminate possible impacts on the blocks not having oil and gas leases. For all blocks on which the construction of gravel islands occurs (24 islands are assumed) impacts associated with the construction of those islands, using material from whatever source obtained, would be the same as those described for the proposal.

There would be no unavoidable adverse effects on North Slope social systems, biological resources, endangered species, or water quality on the blocks affected by this alternative. On all other blocks impacts would be the same as described for the proposal. Cumulative effects are discussed throughout Section IV.B.

D. Alternative III - Delay the Sale

Delay of the proposed arctic sand and gravel lease sale would only affect about 76 percent of the area. Impacts on the blocks that have existing oil and gas leases and subsequent mining and island building activities will be affected as described for the proposal. Only on those blocks where the sand and gravel sale is delayed will impacts to the Inupiat social systems, biological resources, and water quality be delayed. The effects of additional mitigating measures, cumulative effects, and unavoidable adverse effects would be the same as for the proposal only delayed.

Impacts on Endangered Species: Effects associated with this alternative would be essentially the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.2.e.). The magnitude of effects could vary, depending on the population status of affected species, when the delay would end, or when the undesirable effects would occur. Delay of sale would provide additional time for ongoing research to acquire additional data for improving the accuracy and precision of impact prediction. Particularly required is additional information on the response of bowhead whales to certain potential sources of disturbance and additional data on bowhead migration patterns to prove long-term predicted validity. However, with appropriate impact avoiding measures, such studies could be performed concurrently with the proposed sale.

E. Alternative IV - Boulder Patch Deletion

This deletion alternative would provide environmental protectionto the unique biological communities in the Boulder Patch (discussed in Sec. IV.B.2.a.) by deleting those tracts from the lease sale.

1. Impacts on Inupiat Social Systems:

The long historical and current-day use of Cross Island, Narwhal Island and Tigvariak Islands close to these Boulder Patch biological communities indicates their productivity and importance to subsistence hunting and fishing. Table III-2 lists activities regularly pursued from these barrier islands including whaling, sealing, birding, and fishing. Deletion of this area would add protection to these uniquely productive biological areas and the subsistence activities which occur on or close to these islands. This deletion would therefore reduce the short-term localized effects already expected with the proposal.

2. Impacts on Biological Resources

a. Impacts on Stefansson Sound Kelp Communities: There would be no unavoidable adverse effects on the Stefansson Sound kelp communities identified in Section III.C.1. as a result of this alternative. Refer to Section IV.B.2.a. for a discussion of cumulative effects which may result from other sources.

b. Impacts on Plankton, Benthic Invertebrates, and Fish Resources: Effects associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.2.b.), except that biota occurring in the Boulder Patch area would not be affected. The effects of additional mitigating measures, cumulative effects, and unavoidable adverse effects would also be the same as for the proposal.

c. Impacts on Marine and Coastal Birds: Deleting specific tracts which contain known boulder patches would minimize benthic community disruption and disruption of benthic prey species of birds on those specific tracts (see Sec. IV.E.2.a.). For all other lease tracts, impacts on marine and coastal birds and their habitats would be essentially the same as the proposal.

Conclusion: Dredging and artificial island construction is likely to have minor short-term effects and minimal long-term effects on marine and coastal birds and their habitats. Significant long-term regional impacts on marine and coastal birds are very unlikely, as they are for the proposal. Cumulative impacts and unavoidable adverse effects are essentially the same as they are for the proposal.

d. Impacts on Marine Mammals: Deleting specific tracts which contain known boulder patches would minimize disruption to benthic communities and disruption of the benthic prey species of marine mammals on those specific tracts (see Sec. IV.E.2.a.). For all other lease tracts, impacts on marine mammals and their habitats would be essentially the same as the proposal.

Conclusion: Dredging and artificial island construction are likely to have minor short-term effects and minimal long-term effects on marine mammals and their habitats. Significant long-term regional impacts on marine mammals are very unlikely, as they are for the proposal. Cumulative impacts and unavoidable adverse effects are essentially the same as they are for the proposal.

e. Impacts on Endangered Species: Selection of this alternative would not significantly reduce risks to bowhead whales discussed previously because the Boulder Patch is not within the migratory routes of the bowhead, nor is it known bowhead habitat. Localized reductions of industrial activities and associated noise and disturbance can be anticipated with the selection of this alternative, but overall impacts on bowhead whales within the proposed lease sale area would be the same as the proposal. The effect of additional mitigating measures, cumulative effects, and unavoidable adverse effects would be the same as for the proposal.

3. Impacts on Water Quality: The sedimentological and environmental characteristics of the Boulder Patch area are discussed in Section III.A.1. and IV.A.2. Deletion of the Boulder Patch area from sand and gravel leasing would eliminate adverse effects on the water quality in this portion of Stefansson Sound. The effect of this deletion would be that any anticipated dredging operation within the Boulder Patch area would have to be relocated to some other area where the water quality would be adversely affected. Depending on the textural compostion of the material dredged and the current regime, the effect on water quality at an alternative site may be greater or less than it would be in the Boulder Patch.

Conclusion: The effects on the water quality of Alternative IV will be the same as for the proposal.

F. Alternative V - Shoal Deletion

Dredging from areas such as Weller Bank and Stamukhi Shoals may have minor effects in circulation. Weller Bank is considered such a large-scale feature, however, than no long-term adverse impacts are expected. Ice grounding may help replenish the bank. Removing material from Stamukhi Shoals may have a greater impact since the shoals help to ground ice thereby protecting the barrier islands. It is not expected that mining of offshore sand and gravel associated with this lease sale will have a significant long-term effect on circulation patterns. Deposition of the material on gravel islands or causeways will need to be reviewed on a case-by-case basis.

1. Impacts on Inupiat Social Systems: Specific effects on the human environment from this deletion alternative cannot be differentiated from those discussed for the proposal.

2. Impacts on Biological Resources:

a. Impacts on Stefansson Sound Kelp Communities: Effects associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.2.a.). The effect of additional mitigating measures, cumulative effects, and unavoidable adverse effects would also be the same as for the proposal.

b. Impacts on Plankton, Benthic Invertebrates, and Fish Resources: Effects associated with this alternative would be essentially the same as those discussed for the proposal (Sec. IV.B.2.b.), except that biota occurring in the blocks associated with deletion areas would not be affected. The effects of additional mitigating measures, cumulative effects, and unavoidable adverse effects would also be the same as for the proposal.

c. Impacts on Marine and Coastal Birds: Deletion of Weller Bank and Stamukhi shoal tracts would reduce dredging activity disturbance of feeding seabirds and would also reduce the disruption of benthic prey in these tract areas. The effects of dredging and artificial island construction on marine and coastal birds would be somewhat less than the effects under the proposal.

Conclusion: Dredging and artificial island construction are likely to have minor short-term impacts and minimal long-term effects on marine and coastal birds and their habitats. Significant long-term regional impacts on marine and coastal birds are very unlikely, as they are under the proposal. Cumulative impacts and unavoidable adverse effects are essentially the same as they are under the proposal.

d. Impacts on Marine Mammals: Deletion of Weller Bank and Stamukhi shoal tracts would reduce dredging activity disturbance of marine mammals and minimize disruption of benthic prey in these offshore areas. Effects of dredging and artificial island construction on marine mammals would be somewhat less than the effects discussed under the proposal.

Conclusion: Dredging and artificial island construction are likely to have minor short-term impacts and minimal long-term effects on marine mammals and their habitats. Significant long-term regional impacts on marine mammals are very unlikely, as they are under the proposal. Cumulative impacts and unavoidable adverse effects are essentially the same as they are under the proposal.

e. Impacts on Endangered Species: Selection of this alternative would not significantly reduce risks to bowhead whales discussed previously. Other than the anticipated reduction of short-term behavioral responses anticipated from the proposed Shoal Deletion alternative, overall impacts on bowhead whales within the proposed lease sale area would be the same as the proposal. The effect of additional mitigating measures, cumulative effects, and unavoidable adverse effects would be the same as for the proposal.

3. Impacts on Water Quality: The sedimentological characteristics and the environmental features and concerns of the Weller Bank and Stamukhi Shoal areas are discussed in Section III.A. The quality and quantity of the deposits and the current regime make these two shoals prime sites for dredging. The coarse-grained nature of the sediments indicates that relatively little fine-grained material would be introduced into the environment and that any discharged suspensates would be dissipated by the currents. Deletion of these shoals from the sand and gravel lease sale would mean relocating any proposed dredging operations to other areas and would have no adverse effect on the water quality of the shoals. As noted in Section III.A.1., Weller Bank contains a considerable amount of coarse-grained material and might be utilized as a single dredging site for projects requiring large volumes of fill. However, if dredging is prohibited on Weller Bank, several smaller dredging sites may have to be used. Depending on the quality of the dredged material and the oceanographic conditions, the water quality changes caused by dredging at alternative locations may be greater or smaller than it would be at Weller Bank or Stamukhi Shoal.

The effect of removing material from a shoal the size of Weller Bank may not be as serious with regard to the disruption of the sea ice zonation and stability of the landfast ice as was noted in the Beaufort Sea Synthesis-Sale 71 (U.S. Dept. of Commerce, 1981) if only a portion of the shoal is removed (J. Craig, personal communication). Dredging material from an area the size of an OCS lease block, which is 4.80 kilometers (2.98 miles) on a side, down to a depth of 0.9 meters (3 ft) would yield over 21.0 million cubic meters (27.5 million yds^3). This is slightly less than twice the amount of fill needed to construct all the artificial islands built to date in the Beaufort Sea. In time, grounding sea ice may push enough sediment from the surrounding seafloor onto the shoal to replenish any material dredged.

Conclusion: The effects on the water quality of Alternative V will be the same as for the proposal.

G. Impacts on Other Issues

1. Impacts on the Economy:

a. Impacts of the Proposal (Alternative I): Economic impact assessment at the state and regional levels have been thoroughly discussed in both the FEIS's for OCS sale BF and OCS sale 71 and is incorporated herein.

In regard to oil and gas activities and direct employment, it is projected that 12 exploration and 12 production islands will be constructed using fill materials dredged within the arctic sand and gravel lease sale area. The employment figures for dredging, island construction, and transportation support are estimated at 1,370 work-months for exploration islands and 1,586 work-months for production islands based on the assumption that each island will require 2 months of activity and the employees will remain onsite working 12-hour shifts. With the proposed schedule for exploration and production island development, it is estimated that 1,370 work-months will be required for 1983, 2,956 work-months for 1984, 2,740 work-months each for 1985 and 1986, 4,110 work-months each for 1987 and 1988, 4,758 work-months for 1990, and 6,344 work-months each for 1991 and 1992. The employment figures are based on the draft Technical Report "Alaska OCS Socioeconomic Studies Program Barrow Arch Planning Area (Chukchi Sea), Petroleum Technology Assessment, OCS Lease Sale No. 85 (Dames & Moore, 1982).

As stated in the sale 71 FEIS, and as directly applicable to the proposed arctic sand and gravel lease sale, most jobs would be filled by workers who commute during rest periods to permanent residences in other regions of Alaska or out of state. Because the impacts of the proposed sale will occur during a period of expected rapid growth associated with OCS sale 71, it is unlikely to bring about any decrease in joblessness in Alaska. Furthermore, because the mining of sand and gravel is expected to coincide with the oil and gas exploration and development activities in the sale 71 area it is unlikely that inflationary pressures will exist beyond those in the absence of the arctic sand and gravel lease sale. The proposed sand and gravel lease sale will probably bring about no change in property tax revenues to the North Slope Borough.

b. Impacts of Alternatives II through V: For sale alternatives II and III, no sale and delay of sale, respectively, there is a range of possible impacts. Without the sale, the oil and gas industry will either depend upon other sources of available fill material or simply not construct all of the scheduled islands. The postponement or delay of the sale may result in a delay of the proposed development schedules since onshore fill material may necessitate long hauling routes. The impacts for both alternatives IV and V will be the same as those stated for the proposal.

2. Impacts on Coastal Zone Management:

a. Impacts of the Proposal (Alternative I): Impacts associated with this lease sale could affect the Alaska coastal management program in two ways: conflicts could emerge with existing and developing coastal management policies, and there could be a pre-emption of local planning efforts currently underway. The conclusion will address both.

Policies identified in Section III.E.2. as applicable to this sale include habitats, air and water quality, archaeology, subsistence resources, mining, and transportation. The effects of these policies with respect to the proposed sale are discussed drawing from the information contained in other sections of this impact statement.

An overriding consideration in the analysis of the effects of this proposal on specific habitat types is the policy that habitats should be managed to ensure their viability in supporting living resources associated with the habitat. Two habitat types are affected by activities which may result from the proposed sale--offshore habitats and barrier islands and lagoons. In evaluating these habitats, attention is directed toward the impacts of dredging and deposition of dredged material on living resources associated with the habitat.

Evaluation of the offshore habitat is based on the impact analyses contained in Section IV.B.2. These impacts are related to the overriding policy noted above and the policy specific to offshore areas that offshore areas be managed as a fisheries conservation zone. The Boulder Patch is treated separately as a unique offshore habitat.

Effects of dredging and deposition activities tend to be localized and temporal. Effects to benthic invertebrates may be the longest; these communities may require several years to recover. Fish mortality through entrainment would probably be rare since fish density in the lease area is low and offshore from the migration routes of anadromous fish.

Noise may create a greater problem, although that, too, would be of short duration. Bird populations and marine mammals would likely avoid the area due to the noise and the disruption of their food sources.

Continuous noise, such as that associated with dredging, would not necessarily be disruptive to bowhead whales depending upon the site characteristics where the activity is occurring. Sporadic noise associated with barge movements, supply boats, or aircraft could be more disruptive. These types of noise may create an avoidance pattern. Long-term effects, however, are expected to be minimal and long-term regional effects very unlikely. As a result it appears likely that the offshore area will retain its viability as a habitat and fisheries conservation zone.

Dredging in the Boulder Patch, however, may affect the viability of a specific offshore area to support living resources associated with it. It was noted that the removal or destruction of a significant portion of the Boulder Patch would create a situation which would not lead to comparable resettlement. Dredging and deposition in the Boulder Patch or within a buffer zone around it would have an impact upon the habitat which is counter the habitat policy.

Impacts which create conflict with coastal management policies on barrier islands and lagoons are those which alter the physical regime, thereby filling lagoons or accelerating change in barrier islands and activities which disrupt wildlife inhabitants. Barrier islands and lagoons provide habitat for marine and coastal birds and polar bears. Some impacts to bird populations are anticipated. Traditional nesting, feeding, and molting areas may become undesirable because of the noise and activity associated with dredging and deposition activities. Temporary or long-term displacment of nesting birds would reduce their nesting success and disturbance of molting and feeding birds could reduce migration fitness, contributing to increased migration mortality.

Dredging from special areas such as Weller Bank and Stamukhi Shoals may have minor effects on circulation. Weller Bank is considered such a large scale feature, however, that no long-term adverse impacts are expected. Indeed ice grounding may help replenish the bank. Removing material from Stamukhi Shoals may have a greater impact since the shoals help to ground ice thereby protecting the barrier islands.

Alterations of the physical regime which change shoreline dynamics are addressed also in a mining policy proposed by the North Slope Borough. It is not expected that offshore mining of sand and gravel associated with this lease sale will have a significant long-term effect on circulation patterns. Deposition of the material on gravel islands or causeways will need to be reviewed on a case by case basis.

Neither air nor water quality degradation is expected outside the immediate vicinity of the dredge and deposition area. Even within the immediate vicinity impacts are expected to be short-term. As a result there should be no conflict between air and water quality policies and the activities associated with the proposed leases.

No offshore artifacts of historic or prehistoric value have yet been identified in the lease sale area. Although the area has been used traditionally by local residents, and numerous onshore sites have been identified, no onshore development or modifications are assumed to accompany the dredging operations. As a result this policy should not be relevant to the sale. Should conditions change and onshore development occur or offshore artifacts be located, this policy would be applicable.

Since transportation policies are also oriented toward land development, these too, would only be applicable if the assumption concerning land-based facilities proves incorrect. Even extra dockage which is addressed in draft Borough CMP policies is unlikely. It is expected that seaworthy vessels will either depart during the winter months or be frozen into the ice. Docking facilities currently available and which will accompany future oil and gas activities will be adequate to accommodate dockage needs resulting from this lease sale.

Because a local coastal management program has yet to be finalized, activities must be measured against the general state policy of giving full recognition to subsistence use of resources. Onshore subsistence activities should not be affected by dredging and deposition of dredged material. Short-term impacts could result from reduced bird populations or relocated populations which may be less accessible. Bowhead whaling operations may also be hindered if the bowheads move too far offshore in efforts to avoid noise associated with dredging and deposition. Conflict could also arise if barge traffic moving dredged material from a dredge site to deposition site interfere with whalers' maneuvering.

Impacts on the NSB Coastal Management Program: Impacts are experienced in the local planning effort to the extent that the intended purpose of the policies is pre-empted by an activity approved prior to the adoption of a local coastal management program.

Since the proposed activities associated with dredging and filling have no discernible long-term effects on state coastal management policies there should be no long-term pre-emption of the policies of a local program developed consistently with the state coastal management program.

One potential conflict in the short term could center on the proposed NSB policy which stipulates that mining on beaches or offshore is prohibited unless there are no other options. In those instances, substantial alterations to shoreline dynamics is prohibited.

The primary drawback resulting from the incomplete local coastal management program is the lack of specific guidance with respect to areas reserved for priority subsistence use. Maps in draft form, however, provide unofficial guidance.

Conclusion: With the exception of dredging and deposition in or around the Boulder Patch, no long-term local or regional impacts to coastal management program policies are expected as a result of the proposed lease sale. Short-term local conflicts may arise with respect to subsistence uses in the area and with respect to offshore, barrier island, and lagoon habitats. No long-term local conflicts are anticipated. Since the activities demonstrate no long-term impacts, impacts associated with possible pre-emption of local coastal management policies likewise are not significant in the long term.

Cumulative Effects: Dredging operations outside the Boulder Patch would create only local short-term effects, therefore cumulative impacts from dredging should be minimal in the offshore habitat. Island or causeway construction, however, destroys the habitat at the construction site. In addition, the cumulative effect of causeways and nearshore islands could place additional stresses on anadromous fish during migration, affect the fast-ice breeding habitat of ringed seals, have a deleterious effect on water circulation patterns, and alter temperature-salinity regimes. As a result, cumulative impacts from deposition of dredged material could create conflict with the offshore and barrier island/lagoon habitats. Alterations to circulation patterns and temperature salinity regimes associated with cumulative deposition of material along the shorelines would be in conflict with policies for both barrier island and lagoon habitats and for mining. With reductions or shifts in population of subsistence resources an associated conflict may arise with the developing Borough policies on subsistence.

North Slope Borough coastal management policies should be adopted in 1983. As a result they should be in place before cumulative impacts can pre-empt their adoption.

Effect of Additional Mitigating Measures: Proposed mitigating measures regarding dredging and deposition in or around the Boulder Patch or other areas identified in the future as requiring additional protection should be beneficial in minimizing local long-term effects. The mitigating measures regarding subsistence activities and bird and marine mammal protection should help minimize any short-term impacts with respect to subsistence or habitat policies. The Coastal Zone Management information to lessee should provide protection to policies contained in the state Coastal Management Program and proposed for inclusion in the North Slope Borough Coastal Management Program. Corps of Engineers permitting procedures provide a mechanism to alert concerned entities of any activity before it occurs.

Unavoidable Adverse Impacts: Given the accuracy of the assumptions made for this proposal and the implementation of the stipulations, there are no unavoidable long-term impacts to state coastal management policies or the nearly completed coastal management program of the North Slope Borough as a result of dredging activities. Loss of benthic habitat is an unavoidable consequence of filling. However, if placement does not interfere with the physical and chemical regime of the offshore and barrier island/lagoon habitats, then fill activities likewise will have no unavoidable adverse impacts. Short-term local impacts to the habitat associated with dredge and fill activities do not create any unavoidable adverse impacts.

b. Impacts of Alternatives II through V: To the extent that loss of OCS sources of fill material leads to use of material from more sensitive habitats the effects of Alternative II (no sale) could have a greater impact on habitats, cultural resources, or subsistence activities. Cumulative and unavoidable adverse effects are comparable to those for the proposal.

Impacts from Alternative III (delay the sale) are a combination of those from the proposal and Alternative II. Impacts during the delay would be comparable to those with no sale. Thereafter, impacts would be comparable to the proposal. Cumulative and unavoidable adverse effects are comparable to those of the proposal.

Effects of Alternative IV (Boulder Patch) are comparable to those of the proposal with the exception that a localized conflict with offshore habitat policies would not occur. Cumulative and unavoidable adverse effects are comparable to those of the proposal.

The effects resulting from the deletion of Stamukhi Shoals and Weller Bank (Alternative V) would be similar to those of the proposal in most instances. The exception would be if removal of material from these areas did, in fact, alter circulation patterns or shorelines. Such changes are in conflict with coastal management policies on mining and on barrier island/lagoon habitats. Cumulative and unavoidable adverse effects are similar to those of the proposal.

3. Impacts on Transportation Systems:

a. Impacts of the Proposal (Alternative I): The impact of this leasing proposal upon transportation systems is evaluated in context of the scenario assumptions accompanying this EIS. Thus, the assumptions made in Section IV.A.1. regarding transportation of dredging equipment, goods, and personnel form the basis for transportation systems impact assessment here.

With regard to movement of goods and personnel, the existing transportation system serving the North Slope is well suited to respond to changes in demand.

Critical to the flexibility of goods and passenger transportation service to the North Slope is the extensive transportation logistics planning performed by the shippers and North Slope operators. Given the self-contained operations typical of offshore dredging, there should be no added stress to the transportation system as result of this proposed lease. For a more complete description of how change in demand is accommodated, see Section IV.I.2. of the 71 FEIS (USDI, 1982).

Barge and dredge traffic to and from areas of dredging and deposition should not create a strain on existing marine traffic. Sea lifts to the North Slope are planned well in advance. Given good communication between operators, there should be no impacts between these two operations. Small boat traffic is limited, although problems may arise during whaling season. Given the predictable navigation course between an excavation site and a gravel island site, however, potential problems with small boats should be able to be corrected through safe boating practices.

Conclusion: Given the self-contained nature of dredging operations, transport activities associated with this proposal are not expected to yield any significant impacts on regional or statewide transportation systems.

Cumulative Effects: The addition of this proposed lease sale is not expected to yield any measurable difference in cumulative goods and personnel transportation impacts over a "base case" projection of future conditions (no sale alternative) in this EIS. Maritime traffic patterns may need to be somewhat modified, though this is unlikely.

Effect of Additional Mitigating Measures: Coast Guard regulations should mitigate any potential conflict between dredging activities and the sea lift and small boat operators. The potential stipulation concerning dredging operations while whaling boats are in the vicinity would further reduce any potential impacts between the two activities.

Unavoidable Adverse Effects: No unavoidable adverse effects on transportation systems are expected as a result of this proposal.

b. Impacts of Alternative II through V: Alternative II, no sale, could create greater strain on the transportation system. No longer would fill requirements be met through self-contained dredging operations. They would require either more extensive use of onshore sources or alternative island designs. Since non-riverine sources of gravel are preferred by the North Slope Borough, use of onshore gravel may require greater use of onshore trucking. Depending upon where the barges are loaded, greater numbers of barges may be required since the barges may need more shallow drafts to navigate in the river systems. Use of alternative technologies for platforms which do not require gravel would probably increase greatly the tonnage of materials shipped into the Beaufort Sea. Crew needs for these systems would be radically different. Neither of these alternatives involves self-contained units for crews or supplies. As a result, ancillary transportation requirements would also increase. However, the transportation system for trucked and barged material is relatively elastic, therefore cumulative and unavoidable adverse effects associated with using different gravel sources or technologies should be the same as for the proposal.

Assuming gravel islands remain a preferred alternative after a 3-year delay, impacts associated with Alternative III, delay of sale, should be comparable to those of the proposal. Cumulative impacts and unavoidable adverse effects would also be the same as for the proposal.

Impacts associated with Alternatives IV and V would essentially be the same as for the proposal. The primary variation would be that dredged material would need to be barged further should industry construct a gravel island near or on either site. Cumulative and unavoidable adverse effects would be the same as for the proposal.

4. Impacts on Land Use and Land Status:

a. Impacts of the Proposal (Alternative I): Impacts on land use should be limited since no additional shore-based facilities appear to be needed for activities associated with dredging and deposition of dredged material occurring as a result of this lease sale. Seaworthy dredges are essentially self-contained units. Crews typically remain with the dredge for the duration of the job; the only supplies required are fuel, perishable goods, emergency supplies, and possibly one or two food resupplies. Portable dredges will be supported with dormitory and supply barges. It is possible that there may be some crew rotation with this method of dredging and deposition but there should be no need for restocking food supplies.

If this holds true, impacts associated with OCS dredging and deposition would be of a reverse nature whereby offshore material would be used for fill rather than nearshore or onshore material. This alternative would alleviate any land use impacts associated with onshore or nearshore dredging.

Conclusion: No land use impacts are expected due to activities associated with this sale since operations will be confined primarily to the offshore area.

Cumulative Effects: No cumulative impacts are expected due to offshore dredging and deposition.

Unavoidable Adverse Effects: No unavoidable adverse impacts on land use can be identified as a consequence of this leading proposal.

b. Impacts of Alternatives II through V: If no material for gravel islands was available from this lease sale for oil and gas activities in the no sale case, alternative solutions would be required. For example other types of drilling platforms could be developed or fill material could be obtained from sources closer to shore or onshore. If the latter solution were preferred, removal of onshore or nearshore sources of material could have a greater impact on land use than the proposal.

Alternative III, Delay of Sale, would create impacts during the delay similar to those noted for no sale. Once the sale were held, impacts on land use would be comparable to those of the proposal.

The effects of Alternative IV and V (area deletions) should not create impacts on land use different from those of the proposal. An exception might occur if offshore excavation from the shoal area accelerated change to or modified the shoreline.

Effects of deposition of material, assuming islands were the preferred platform base, would be comparable for all alternatives.

Cumulative impacts and unavoidable long-term effects would be comparable to those of the proposal.

5. Impacts on Cultural Resources:

a. Impacts of the Proposal (Alternative I): The impacts on cultural resources have been assessed in the BF FEIS (USDI, 1979) and in the 71 FEIS (USDI, 1982). Alaska OCS Technical Paper No. 6 (Tornfelt, 1982) describes these resources in detail. The mining of gravel resources from the ocean floor could significantly affect potential archaeological sites by the destruction or the burial of artifacts during the process of facility construction. The increased sedimentation resulting from such activities could further affect archaeologic sites by substantially increasing sediment cover which could significantly reduce the ability of remote sensing technology to detect sites. However, since water dynamics and ice gouging have rearranged most artifacts, little useful information can be gathered in areas of low probability of human habitation due to lack of context with existing land forms (Dixon, 1978).

The mining of gravel resources and the construction of artificial islands could cause significant adverse effects to unidentified paleontologic floral and faunal remains. The loss of such specimens could severely limit scientific knowledge of paleoecologic conditions within the region. Such impacts are anticipated to be low as both federal and state laws allow for the protection of paleontologic remains and such remains have been greatly disturbed by ice gouging and are entirely out of context with land forms.

Conclusion: Considering the water dynamics and ice gouging on the marine bottom, the proposal's impact on marine cultural resources and paleontological resources is low. Damage to onshore cultural resources is low since personnel and facilities on the dredges remain offshore.

Cumulative Effects: The cumulative impact of other private, state, and federal projects, together with the effects of the proposal, result in a high probability of interaction with cultural resources. See the Sale 71 FEIS pages 232 and 233 for details (USDI, 1982).

Effect of Additional Mitigating Measures: When there is likelihood of damage to cultural resources (as determined by the Deputy Minerals Manager, Offshore Field Operations (DMMOFO) based on standard surveys and data collection), the cultural resources stipulation could then be put in effect and consultation with the Minerals Management Service Historic Preservation Officer (MMSHPO) could be initiated by the lessee. The application of the protective methods of that stipulation and those of the orientation program stipulation would reduce the chance of impact on cultural resources and paleontological resources from low to very low.

Unavoidable Adverse Effects: Unavoidable adverse impacts would be destruction of marine cultural resources such as housepits, burins, scrapers, arrowheads, and other artifacts. Unavoidable impacts to these marine resources are unlikely, given the great water and ice dynamics on the marine bottom.

b. Impacts of Alternatives II through V: Alternative II (no sale) would eliminate potential impacts and Alternative III (delay the sale) would delay the impacts of the proposal. Alternative IV (Boulder Patch Deletion) does not reduce impacts to cultural resources since it does not remove any blocks with probability of human habitation. Alternative V (Shoal deletion) lowers the proposal's impacts about 5 percent since tracts 385, 386, 16, 17, 18, 60, 61, and 62 are deleted. However, with the cultural resource stipulation in place, impact to these resources will be very slight (1%) and reduction by this alternative very slight (1%).

Cumulative Effects: Alternative IV would have no cumulative effects. The cumulative effects on cultural resources discussed in the proposal will be reduced (1%) by Alternative V.

Effects of Additional Mitigating Measures: This effect is the same as for the proposal.

Unavoidable Adverse Effects: These effects will not be reduced appreciably by Alternatives II through V.

6. Impacts on Visual, Recreation, Tourism, and Wilderness Resources:

a. Impacts of the Proposal (Alternative I): These impacts are described in detail on pages 264-267 of the BF FEIS (USDI, 1979) and in the 71 FEIS pages 234-236 (USDI, 1982).

The gravel islands produced by the proposal will have a low relief of approximately 20 feet above the water level when finished. This low relief will not be visible outside the 12 miles from shore zone which is considered a reasonable distance for minimum visual impact. Dredging equipment used during the building of the island will produce some impact but only for the time of island construction. In view of the requirement of the BF Notice of Sale that such facilities as gravel islands be removed to the extent that they no longer intrude on the cultural scene, the above impacts should be minimal. The majority of the artificial islands for the sale 71 area will probably be beyond 12 miles from shore.

Conclusion: Adverse impacts to recreational, visual, tourism, and wilderness resources as a result of dredging will be low.

Unavoidable Adverse Effects: Unavoidable adverse impacts to visual resources would be abandoned exploration and/or development islands, damage to visual landmarks, or damage to ground vegetation which could result in alteration of the landscape. This damage is unavoidable unless there is a stipulation to restore the gravel island area to its original state as was stipulated in the BF area.

b. Impacts of Alternatives II through V: Alternatives II (no sale) and Alternative III (delay the sale) would eliminate impacts and delay impacts respectively. Alternatives IV does not reduce impacts to visual, recreation, tourism and wilderness resources since it is outside of the visual 12 mile zone. Alternative V, being closer to shore and near the 12-mile criteria line, reduces impacts to very low. The effect of additional mitigating measures, cumulative effects and unavoidable adverse effects would be the same as for the proposal.

7. Impacts on Air Quality:

a. Impacts of the Proposal (Alernative I): Impacts on air quality from the proposal are expected to be insignificant. No violations of any Federal or State of Alaska air quality standards or of U.S. EPA Prevention of Significant Deterioration requirements are anticipated.

b. Impacts of Alternatives II Through V: In the event there is no lease sale (Alernative II) dredging operations would not take place and there would consequently be no impact on the air quality. Impacts on the air quality for Alternatives III through V would be the same as for the Proposal, Alternative I.

H. Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity

In this section, the short-term effects and uses of various components of the environment of the Beaufort Sea area are related to long-term effects and the maintenance and enhancement of long-term productivity. The effects of the proposed action would vary in kind, intensity, and duration, beginning with preparatory activities (bottom sediment collection, core drilling, and grab sampling), through sand and gravel extraction and deposition, and ending when natural environmental balances might be restored.

In general, short-term refers to the useful lifetime of the proposal (as long as oil and gas is produced in the Beaufort Sea), but some even shorter-term uses and effects are considered. Long-term refers to that time beyond the lifetime of the proposal. In other words, short-term refers to the total duration of oil and gas exploration and production, and the need for sand and gravel resources, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. This period will vary from one environmental component to another.

Most of the impacts discussed in Section IV are considered to be short-term (being greatest during the construction, exploration, and early production phases), which could be further reduced by the mitigating measures discussed in Section II.B.1.c.

In the short term, biological productivity would be reduced on offshore lands used in the proposed project; however, these areas would return to productivity in the short term. Mining and deposition could cause definite changes in both the short term and long term. Some species may have difficulty repopulating and could be displaced.

The biota would be threatened in the short term by mining activities. Displacement could be local and moderate through the combined effects of harassment by humans and the increased volume and frequency of noise from vessel traffic or overflying aircraft. In the long term, such disturbances could alter behavior patterns and could drive animals away from traditional feeding and breeding grounds or to other habitat areas within their range, reducing species local populations over a short period of time.

Increased human populations in the short term could change the regional Native culture in the long term. The subsistence way of life could be modified and population shifts could occur in the short term because of increased activity (Sec. IV.B.1.).

Archaeologic and historic finds discovered during development would enhance long-term knowledge. Finds may help to locate other sites, but destruction of artifacts would represent long-term losses.

As explained in the preceding impact sections, alternatives to the proposal such as cancellation, delay, and partial deletion options reduce to varying degrees both the long- and short-term environmental effects as well as the long- and short-term energy supply benefits.

I. Irreversible and Irretrievable Commitment of Resources

1. Mineral Resources: Resource estimates of sand and gravel for the proposed action are incomplete and are not available area wide. Known resources, however, are estimated to be sufficient to support oil and gas development and other activities. These fill materials may be removed from their existing areas and placed in another location of the Beaufort Sea. They will still retain their essential qualities and will not be irretrievably consumed nor irreversibly committed.

2.. Social Systems: The primary structure of Inupiat social and political organization, culture, and identity is centered around the hunting of bowhead whales; sharing and distributing the hunt; and celebrations, crafts, and related activities associated with whale hunting. Virtually every family on the North Slope is connected to whaling through personal experience in one or more aspects of the whaling complex. While other biological resources could be substituted, if bowhead whales were no longer available, there would be an an irreversible and irretrievable loss of culture, meaning, and purpose in Inupiat society. The risks of disturbances associated with this sale, when combined with other risks to the bowhead whale from Alaskan and Canadian Beaufort oil and gas development and tankering activity and Bering Sea and Pacific OCS sales which transect the bowhead's traditional migratory routes, could contribute to these losses. There will be an accelerated decline in the Inupiat social system which must be considered an irretrievable loss.

Irretrievable material products of prehistoric culture such as archaeological sites may be lost through mining and construction activities associated with this proposal. The orientation program and the cultural resource stipulations (Sec. II.B.1.c.) protect against most, but nct all, such losses.

3. Biological Resources: General industry activities, such as increased ship traffic, exploration activities, and aircraft noise could displace marine and terrestrial birds and mammals into less favorable environments. This would eventually result in reduced population levels. This displacement could become irretrievable if permanent alterations to the environment and habitat were maintained by man.

4. Endangered Species: Under the proposal, it is possible that endangered whales could be subjected to irreversible direct and indirect disturbance due to noise and other human activities, or losses and/or deterioration of habitat due to facility developments. Whether such effects would lead to permanent (irreversible) losses of whale resources is unknown (see Sec. IV.B.2.e., Impacts on Endangered Species).

degrees both the long- and short-term environmental effects as well as the long- and short-term energy supply benefits.

1. Irreversible and Irretrievable Commitment of Resources

1. Mineral Resources: Resource [illegible] of [illegible] the proposed action are incomplete and are not available area wide. Known resources, however, are estimated to be sufficient to support oil and gas development and other activities. [illegible] activity may be [illegible] quantity [illegible] another [illegible] They will still retain their [illegible] and will not be irretrievably [illegible] now irretrievably committed.

2. Social Systems: The primary [illegible] social and political organization, culture, and identity is centered around the hunting of marine [illegible] and distributing [illegible] and related activities and rituals of whale hunting. [illegible] through personal experience in [illegible] no longer [illegible] and irretrievable [illegible] cultural meaning and [illegible] This [illegible] when combined with other risks in the proposed [illegible] and Canadian [illegible] oil and gas development and tankering activity and [illegible] area.

V.

CONSULTATION

AND

COORDINATION

V. CONSULTATION AND COORDINATION

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B. Development of the Proposal

The proposed sale of arctic sand and gravel in the Beaufort Sea is the only one being considered at this time. Official coordination with other government agencies, industry, and the public regarding this proposal began in Feburary 1982. BLM requested resource reports from MMS branches with expertise pertinent to the proposal and the proposed sale area in March 1982.

C. Development of the DEIS

During preparation of this DEIS, federal, state, and local agencies; industry; and the public have been consulted in order to obtain descriptive information, to identify significant impacts and issues, and to identify effective mitigating measures and reasonable alternatives to the proposal. The information received has been used in preparing the DEIS.

D. Results of the Scoping Process:

There were no scoping meetings held specifically for this proposal. A public information document containing a request for comments bearing on the scope of this EIS was sent out September 15, 1982. Staff-recommended alternatives and a list of major issues developed from past public response activities conducted for sales BF and 71 were also included. Eight written comments were received. No new issues or alternatives were identified.

Block deletion alternatives discussed during the scoping process were analyzed and are included in the DEIS. They are as follows:

- The Boulder Patch Deletion Alternative IV (Fig. II-3)
- The Shoal Deletion Alternative V (Fig. I-1)

The major issues identified in the information document and addressed in the DEIS are as follows:

Birds
Bowhead Whales
Coastal Zone Management
Cultural Resources
Endangered Species
Ice Hazards
Inupiat Lifestyle and Culture
Marine Mammals
Plankton, Benthic
Invertebrates and Fish Resources
Subsistence
Water Quality

The following environmental issues were raised in the scoping process:

1. Support the delay of the sale alternative until regulations and procedures are developed;

2. Recommend offshore rather than onshore mining activities because they were more environmentally acceptable at proper locations (not identified);

3. Support for both deletion alternatives;

4. Delay the sale until the MMS 1983-84 studies are completed;

5. Support for onshore borrow areas rather than offshore areas;

6. Dredge sites should be carefully considered as to effects;

7. Impacts on bowhead whales, birds, and migrating fish should be carefully assessed. Other comments received require policy considerations. Decisions bearing on these considerations will be made in the later phases of the sale process and, as appropriate, published in the Notice of Sale as required by the OCSLA.

All of these issues and concerns have been addressed in the DEIS. In addition, the major issues raised in previous scoping activities for the Beaufort Sea area are also discussed and impacts on them have been analyzed.

The summary section contains a list of the Federal, state, and local government agencies, academic institutions, industrial firms, special interest groups, and private citizens consulted prior to and during the preparation of this environmental impact statement.

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APPENDICES

APPENDIX A

LIST OF BLOCKS COMPRISING THE PROPOSED ACTION,
INCLUDING DISTANCE FROM SHORE,
WATER DEPTH, AND SIZE

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-1	742	2304.00	5693.18	---	---
	743	2304.00	5693.18	---	---
	744	2304.00	5693.18	---	---
	786	2304.00	5693.18	---	---
	787	2304.00	5693.18	---	---
	788	2304.00	5693.18	---	---
	789	2304.00	5693.18	---	---
	790	2304.00	5693.18	---	---
	791	2304.00	5693.18	---	---
	792	2304.00	5693.18	---	---
	830	2304.00	5693.18	---	---
	831	2304.00	5693.18	---	---
	832	2304.00	5693.18	---	---
	833	2304.00	5693.18	---	---
	834	2304.00	5693.18	---	---
	835	2304.00	5693.18	---	---
	836	2304.00	5693.18	---	---
	874	2304.00	5693.18	---	---
	875	2304.00	5693.18	---	---
	876	2304.00	5693.18	---	---
	877	2304.00	5693.18	25	17
	878	2304.00	5693.18	25	11
	879	2304.00	5693.18	25	16
	880	2304.00	5693.18	25	19
	918	2304.00	5693.18	---	---
	919	2304.00	5693.18	---	---
	920	2304.00	5693.18	---	---
	921	2304.00	5693.18	20	14
	922	2304.00	5693.18	20	13
	923	2304.00	5693.18	20	13
	924	2304.00	5693.18	20	12
	962	2304.00	5693.18	---	---
	963	2304.00	5693.18	---	---
	964	2304.00	5693.18	---	---
	965	2304.00	5693.18	15	13
	966	2304.00	5693.18	15	10
	967	2304.00	5693.18	15	9
	968	2304.00	5693.18	15	10
	1006	2304.00	5693.18	---	---
	1007	2304.00	5693.18	---	---
	1008	2304.00	5693.18	---	---
	1009	2304.00	5693.18	10	8
	1010	2304.00	5693.18	10	8
	1011	2304.00	5693.18	10	7
	1012	2304.00	5693.18	10	8
NR 5-2	749	2304.00	5693.18	40	20
	750	2304.00	5693.18	---	---
	751	2304.00	5693.18	---	---

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-2	752 *	2304.00	5693.18	---	---
	793	2304.00	5693.18	---	---
	794	2304.00	5693.18	---	---
	795	2304.00	5693.18	---	---
	796	2304.00	5693.18	---	---
	797	2304.00	5693.18	---	---
	798	2304.00	5693.18	---	---
	799	2304.00	5693.18	---	---
	800	2304.00	5693.18	---	---
	801	2304.00	5693.18	---	---
	802	2304.00	5693.18	---	---
	803	2304.00	5693.18	---	---
	804	2304.00	5693.18	---	---
	837	2304.00	5693.18	25	13
	838	2304.00	5693.18	---	---
	839	2304.00	5693.18	---	---
	840	2304.00	5693.18	---	---
	841	2304.00	5693.18	---	---
	842	2304.00	5693.18	---	---
	843	2304.00	5693.18	---	---
	844	2304.00	5693.18	---	---
	845	2304.00	5693.18	---	---
	846	2304.00	5693.18	---	---
	847	2304.00	5693.18	---	---
	848	2304.00	5693.18	---	---
	849	2304.00	5693.18	---	---
	850	2304.00	5693.18	---	---
	851	2304.00	5693.18	---	---
	852	2304.00	5693.18	---	---
	853	2304.00	5693.18	---	---
	854	2304.00	5693.18	---	---
	881	2304.00	5693.18	20	12
	882	2304.00	5693.18	20	12
	883	2304.00	5693.18	20	11
	884	2304.00	5693.18	20	14
	885	2304.00	5693.18	20	15
	886	2304.00	5693.18	15	15
	887	2304.00	5693.18	15	17
	888	2304.00	5693.18	15	17
	889	2304.00	5693.18	15	19
	890	2304.00	5693.18	15	20
	891	2304.00	5693.18	15	22
	892	2304.00	5693.18	15	23
	893	2304.00	5693.18	15	25
	894	2304.00	5693.18	20	26
	895	2304.00	5693.18	20	28
	896	2304.00	5693.18	25	31
	897	2304.00	5693.18	25	34

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-2	898	2304.00	5693.18	---	---
	899	2304.00	5693.18	---	---
	900	2304.00	5693.18	---	---
	901	2304.00	5693.18	---	---
	925	2304.00	5693.18	15	10
	926	2304.00	5693.18	15	16
	927	2304.00	5693.18	15	10
	928	2304.00	5693.18	15	12
	929	2304.00	5693.18	15	12
	930	2304.00	5693.18	15	12
	931	2304.00	5693.18	15	13
	932	2304.00	5693.18	15	15
	933	2304.00	5693.18	15	16
	934	2304.00	5693.18	15	17
	935	2304.00	5693.18	15	20
	936	2304.00	5693.18	15	22
	937	2304.00	5693.18	15	23
	938	2304.00	5693.18	20	25
	939	2304.00	5693.18	20	28
	940	2304.00	5693.18	25	30
	941	2304.00	5693.18	25	33
	942	2304.00	5693.18	25	35
	943	2304.00	5693.18	25	37
	944	2304.00	5693.18	---	---
	945	2304.00	5693.18	---	---
	946	2304.00	5693.18	---	---
	947	1523.94	3763.43	---	---
	969	2304.00	5693.18	10	7
	970	2304.00	5693.18	10	7
	971	2304.00	5693.18	10	7
	972	2304.00	5693.18	10	8
	973	2304.00	5693.18	10	10
	974	2304.00	5693.18	10	10
	975	2304.00	5693.18	10	11
	976	2304.00	5693.18	10	13
	977	2304.00	5693.18	10	14
	978	2304.00	5693.18	10	15
	979	2304.00	5693.18	10	17
	980	2304.00	5693.18	10	19
	981	2304.00	5693.18	10	21
	982	2304.00	5693.18	20	23
	983	2304.00	5693.18	20	27
	984	2304.00	5693.18	20	25
	985	2304.00	5693.18	20	31
	986	2304.00	5693.18	20	33
	987	2304.00	5693.18	20	32
	988	2304.00	5693.18	---	---
	989	2304.00	5693.18	---	---

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-2	990	2304.00	5693.18	---	---
	991	1637.22	4045.57	---	---
NR 5-3	38	2304.00	5693.18	---	---
	39	2304.00	5693.18	---	---
	40	2304.00	5693.18	---	---
	41	2304.00	5693.18	10	6
	42	1807.33	4465.91	10	5
	43	1239.55	3062.93	10	4
	44	1502.07	3711.61	10	4
	82	599.00	1480.13	---	---
	83	461.00	1139.13	---	---
	84	634.00	1566.61	---	---
	85	687.95	1699.92	5	4
	86	13.94	34.45	5	4
NR 5-4	1	1956.66	4834.91	10	4
	2	2112.25	5219.37	10	4
	3	2304.00	5693.18	10	4
	4	2304.00	5693.18	10	8
	5	2304.00	5693.18	10	7
	6	2304.00	5693.18	10	8
	7	2304.00	5693.18	10	8
	8	2304.00	5693.18	10	10
	9	2304.00	5693.18	10	11
	10	2304.00	5693.18	10	13
	11	2304.00	5693.18	15	15
	12	2304.00	5693.18	15	17
	13	2304.00	5693.18	15	20
	14	2304.00	5693.18	15	23
	15	2304.00	5693.18	15	25
	16	2304.00	5693.18	15	28
	17	2304.00	5693.18	20	30
	18	2304.00	5693.18	20	32
	19	2304.00	5693.18	20	33
	20	2304.00	5693.18	20	32
	21	2304.00	5693.18	20	32
	22	2304.00	5693.18	25	32
	23	1751.37	4327.64	25	33
	46	80.89	199.88	10	3
	47	946.55	2338.93	10	3
	48	1230.47	3040.49	10	3
	49	2045.73	5055.00	10	3
	50	2304.00	5693.18	10	5
	51	2304.00	5693.18	10	7
	52	2304.00	5693.18	15	8
	53	2304.00	5693.18	15	10
	54	2304.00	5693.18	15	12
	55	2304.00	5693.18	15	13
	56	2304.00	5693.18	15	16

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-4	57	2304.00	5693.18	15	19
	58	2304.00	5693.18	15	22
	59	2304.00	5693.18	15	25
	60	2304.00	5693.18	15	26
	61	2304.00	5693.18	20	28
	62	2304.00	5693.18	20	28
	63	2304.00	5693.18	20	26
	64	2304.00	5693.18	20	26
	65	2304.00	5693.18	25	28
	66	2304.00	5693.18	25	28
	67	1865.49	4609.63	25	28
	93	28.58	70.62	---	---
	94	784.55	1938.62	10	3
	95	1897.28	4688.18	10	3
	96	2304.00	5693.18	10	5
	97	2304.00	5693.18	10	6
	98	2304.00	5693.18	15	10
	99	2304.00	5693.18	15	13
	100	2304.00	5693.18	15	16
	101	2304.00	5693.18	15	18
	102	2304.00	5693.18	15	20
	103	2304.00	5693.18	15	23
	104	2304.00	5693.18	20	25
	105	2304.00	5693.18	20	25
	106	2304.00	5693.18	20	26
	107	2304.00	5693.18	20	24
	108	2304.00	5693.18	20	24
	109	2304.00	5693.18	25	23
	110	2304.00	5693.18	25	25
	111	1979.58	4891.54	25	25
	139	124.93	308.70	10	3
	140	2132.98	5270.59	10	3
	141	2304.00	5693.18	10	7
	142	2304.00	5693.18	10	10
	143	2304.00	5693.18	15	13
	144	2304.00	5693.18	15	15
	145	2304.00	5693.18	15	17
	146	2304.00	5693.18	15	19
	147	2304.00	5693.18	15	22
	148	2304.00	5693.18	20	23
	149	2304.00	5693.18	20	23
	150	2304.00	5693.18	20	23
	151	2304.00	5693.18	20	23
	152	2304.00	5693.18	20	23
	153	2304.00	5693.18	20	23
	154	2304.00	5693.18	20	22
	155	2093.64	5173.38	20	22
	184	1171.93	2895.84	10	5

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-4	185	2304.00	5693.18	10	7
	186	2304.00	5693.18	10	10
	187	2304.00	5693.18	10	12
	188	2304.00	5693.18	15	14
	189	2304.00	5693.18	15	17
	190	2304.00	5693.18	15	18
	191	2304.00	5693.18	15	20
	192	2304.00	5693.18	15	22
	193	2304.00	5693.18	15	21
	194	2304.00	5693.18	15	20
	195	2304.00	5693.18	20	19
	196	2304.00	5693.18	20	19
	197	2304.00	5693.18	20	19
	198	2304.00	5693.18	20	20
	199	2207.67	5455.15	20	20
	228	44.91	110.97	---	---
	229	1833.68	4531.02	10	8
	230	2304.00	5693.18	10	11
	231	2304.00	5693.18	10	13
	232	2304.00	5693.18	15	14
	233	2304.00	5693.18	15	15
	234	2304.00	5693.18	15	17
	235	2304.00	5693.18	15	19
	236	2304.00	5693.18	15	20
	237	2304.00	5693.18	15	19
	238	2304.00	5693.18	15	18
	239	2304.00	5693.18	15	17
	240	2304.00	5693.18	15	17
	241	2304.00	5693.18	15	17
	242	2304.00	5693.18	15	18
	243	2297.22	5676.43	15	18
	244	24.45	60.42	15	18
	273	357.06	882.30	10	9
	274	2213.92	5470.60	10	10
	275	2304.00	5693.18	10	10
	276	2304.00	5693.18	10	11
	277	2304.00	5693.18	15	13
	278	2304.00	5693.18	15	15
	279	2304.00	5693.18	15	17
	280	2304.00	5693.18	15	17
	281	2304.00	5693.18	15	16
	282	2304.00	5693.18	15	15
	283	2304.00	5693.18	15	16
	284	2304.00	5693.18	15	13
	285	2304.00	5693.18	15	13
	286	2304.00	5693.18	15	15
	287	2304.00	5693.18	15	14
	288	131.64	325.28	15	14

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-4	318	959.44	2370.78	10	8
	319	2304.00	5693.18	10	8
	320	2304.00	5693.18	10	9
	321	2304.00	5693.18	10	11
	322	2304.00	5693.18	10	14
	323	2304.00	5693.18	10	15
	324	2304.00	5693.18	10	14
	325	2304.00	5693.18	10	13
	326	2304.00	5693.18	10	12
	327	2304.00	5693.18	10	12
	328	2304.00	5693.18	10	10
	329	2304.00	5693.18	10	11
	330	2304.00	5693.18	10	12
	331	2304.00	5693.18	10	13
	332	245.58	606.83	10	12
	362	7.32	18.09	---	---
	363	1644.50	4063.56	10	5
	364	2304.00	5693.18	10	7
	365	2304.00	5693.18	10	10
	366	2304.00	5693.18	10	12
	367	2304.00	5693.18	10	12
	368	2304.00	5693.18	10	11
	369	2304.00	5693.18	10	10
	370	2304.00	5693.18	10	9
	371	2304.00	5693.18	10	8
	372	2304.00	5693.18	10	8
	373	2248.68	5556.49	10	8
	374	1384.11	3420.14	10	10
	375	1535.76	3794.86	10	11
	376	217.81	538.21	10	10
	407	189.05	467.14	10	4
	408	1752.27	4329.86	10	5
	409	2304.00	5693.18	10	9
	410	2304.00	5693.18	10	10
	411	2304.00	5693.18	10	9
	412	2304.00	5693.18	10	8
	413	2304.00	5693.18	10	7
	414	2298.51	5679.62	10	6
	415	2201.55	5440.03	10	5
	416	1805.51	4461.42	10	5
	417	839.05	2073.29	10	6
	452	884.91	2186.61	5	5
	453	2304.00	5693.18	5	7
	454	2304.00	5693.18	5	7
	455	2304.00	5693.18	5	7
	456	2300.22	5685.33	5	6
	457	1170.40	2892.06	5	5
	458	90.65	224.00	5	4

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 5-4	459	3.27	8.08	5	4
	496	1165.06	2878.86	5	4
	497	2017.01	4984.03	5	4
	498	1708.32	4221.26	5	3
	499	786.04	1942.30	5	4
	500	303.74	750.54	5	4
NR 6-1	946	1523.04	3763.43	---	---
	947	2304.00	5693.18	---	---
	990	1637.22	4045.57	---	---
	991	2304.00	5693.18	---	---
	992	2304.00	5693.18	---	---
	993	2304.00	5693.18	---	---
	994	2304.00	5693.18	---	---
	995	2304.00	5693.18	---	---
	996	2304.00	5693.18	---	---
NR 6-3	22	1751.37	4327.64	30	30
	23	2304.00	5693.18	30	29
	24	2304.00	5693.18	30	28
	25	2304.00	5693.18	30	28
	26	2304.00	5693.18	30	28
	27	2304.00	5693.18	35	28
	28	2304.00	5693.18	---	---
	29	2304.00	5693.18	---	---
	30	2304.00	5693.18	---	---
	66	1865.49	4609.63	25	27
	67	2304.00	5693.18	25	26
	68	2304.00	5693.18	30	25
	69	2304.00	5693.18	30	25
	70	2304.00	5693.18	30	25
	71	2304.00	5693.18	35	24
	72	2304.00	5693.18	---	---
	73	2304.00	5693.18	---	---
	74	2304.00	5693.18	---	---
	110	1979.58	4891.54	25	23
	111	2304.00	5693.18	25	22
	112	2304.00	5693.18	25	22
	113	2304.00	5693.18	30	22
	114	2304.00	5693.18	30	23
	115	2304.00	5693.18	30	24
	116	2304.00	5693.18	30	24
	117	2304.00	5693.18	---	---
	118	2304.00	5693.18	---	---
	154	2093.64	5173.38	25	22
	155	2304.00	5693.18	25	21
	156	2304.00	5693.18	25	21
	157	2304.00	5693.18	25	20
	158	2304.00	5693.18	30	20
	159	2304.00	5693.18	30	20

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 6-3	160	2304.00	5693.18	30	22
	161	2304.00	5693.18	---	---
	162	2304.00	5693.18	---	---
	163	2304.00	5693.18	---	---
	198	2207.67	5455.15	20	20
	199	2304.00	5693.18	20	18
	200	2304.00	5693.18	20	17
	201	2304.00	5693.18	20	17
	202	2304.00	5693.18	20	17
	203	2304.00	5693.18	25	16
	204	2304.00	5693.18	25	15
	205	2304.00	5693.18	---	---
	206	2304.00	5693.18	---	---
	207	2304.00	5693.18	---	---
	208	2304.00	5693.18	---	---
	209	2304.00	5693.18	---	---
	210	2304.00	5693.18	---	---
	241	24.45	60.42	20	17
	242	2297.22	5676.43	20	17
	243	2304.00	5693.18	20	16
	244	2304.00	5693.18	20	16
	245	2304.00	5693.18	20	15
	246	2304.00	5693.18	20	15
	247	2304.00	5693.18	20	15
	248	2304.00	5693.18	25	14
	249	2304.00	5693.18	---	---
	250	2304.00	5693.18	---	---
	251	2304.00	5693.18	---	---
	252	2304.00	5693.18	---	---
	253	2304.00	5693.18	---	---
	254	2304.00	5693.18	---	---
	255	2304.00	5693.18	---	---
	256	2304.00	5693.18	---	---
	285	131.66	325.28	15	14
	286	2304.00	5693.18	15	14
	287	2304.00	5693.18	15	13
	288	2304.00	5693.18	15	13
	289	2304.00	5693.18	15	12
	290	2304.00	5693.18	15	12
	291	2304.00	5693.18	20	12
	292	2304.00	5693.18	20	14
	293	2304.00	5693.18	25	15
	294	2304.00	5693.18	25	16
	295	2304.00	5693.18	25	17
	296	2304.00	5693.18	---	---
	297	2304.00	5693.18	---	---
	298	2304.00	5693.18	---	---
	299	2304.00	5693.18	---	---

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 6-3	300	2304.00	5693.18	---	---
	301	2304.00	5693.18	---	---
	329	245.50	606.63	15	11
	330	2304.00	5693.18	15	11
	331	2304.00	5693.18	15	10
	332	2304.00	5693.18	15	10
	333	2304.00	5693.18	15	10
	334	2304.00	5693.18	15	9
	335	2304.00	5693.18	15	11
	336	2304.00	5693.18	20	12
	337	2304.00	5693.18	20	13
	338	2304.00	5693.18	20	13
	339	2304.00	5693.18	25	14
	340	2304.00	5693.18	---	---
	341	2304.00	5693.18	---	---
	342	2304.00	5693.18	---	---
	343	2304.00	5693.18	---	---
	345	2304.00	5693.18	---	---
	346	2304.00	5693.18	---	---
	373	174.03	430.03	15	9
	374	843.74	2084.78	15	9
	375	739.92	1828.34	15	8
	376	684.21	1690.68	15	8
	377	1175.62	2904.96	15	8
	378	1873.21	4628.70	15	8
	379	2304.00	5693.18	15	9
	380	2304.00	5693.18	15	9
	381	2304.00	5693.18	15	10
	382	2304.00	5693.18	20	10
	383	2304.00	5693.18	20	11
	384	2304.00	5693.18	---	---
	385	2304.00	5693.18	---	---
	386	2304.00	5693.18	---	---
	387	2304.00	5693.18	---	---
	388	2304.00	5693.18	---	---
	389	2304.00	5693.18	---	---
	390	2304.00	5693.18	---	---
	391	2304.00	5693.18	---	---
	392	2304.00	5693.18	---	---
	422	5.50	13.59	---	---
	423	536.32	1325.25	15	7
	424	1414.17	3494.46	15	7
	425	2269.72	5608.48	15	7
	426	2304.00	5693.18	15	8
	427	2304.00	5693.18	15	10
	428	2304.00	5693.18	---	---
	429	2304.00	5693.18	---	---
	430	2304.00	5693.18	---	---

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 6-3	431	2304.00	5693.18	---	---
	432	2304.00	5693.18	---	---
	433	2304.00	5693.18	---	---
	434	2304.00	5693.18	---	---
	435	2304.00	5693.18	---	---
	436	2304.00	5693.18	---	---
	437	2304.00	5693.18	---	---
	469	588.89	1455.15	15	6
	470	1246.39	3079.83	13	6
	471	2004.00	4951.88	---	---
	472	2304.00	5693.18	---	---
	473	2108.00	5208.87	---	---
	474	1267.00	3130.76	---	---
	475	1939.12	4791.71	15	13
	476	1903.45	4703.42	16	13
	477	941.98	2327.63	18	14
	478	1808.35	4468.43	19	15
	479	2304.00	5693.18	---	---
	480	2304.00	5693.18	---	---
	481	2304.00	5693.18	---	---
	482	2304.00	5693.18	---	---
	483	2304.00	5693.18	---	---
	484	2304.00	5693.18	---	---
	515	127.00	313.82	---	---
	516	2051.00	5068.02	---	---
	517	818.00	2021.28	---	---
	519	23.00	56.83	---	---
	520	161.00	397.83	---	---
	522	256.93	634.87	16	12
	523	2304.00	5693.18	16	14
	524	2304.00	5693.18	20	16
	525	2304.00	5693.18	---	---
	526	2304.00	5693.18	---	---
	527	2304.00	5693.18	---	---
	528	2304.00	5693.18	---	---
	560	35.00	86.49	---	---
	561	461.00	1139.13	---	---
	562	161.00	397.83	---	---
	564	299.00	738.83	---	---
	566	23.00	56.83	---	---
	567	438.00	1082.30	---	---
	568	1933.86	4778.57	12	14
	569	1890.72	4671.97	17	17
	570	2304.00	5693.18	---	---
	571	2304.00	5693.18	---	---
	572	2304.00	5693.18	---	---
	605	69.00	170.50	---	---
	606	714.00	1764.29	---	---

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 6-3	607	588.00	1452.95	---	---
	608	1889.00	4667.72	---	---
	609	1359.00	3358.09	---	---
	610	46.00	113.67	---	---
	613	4.98	12.31	11	14
	614	1278.25	3158.56	14	16
	615	2290.93	5659.66	18	16
	616	2304.00	5693.18	---	---
	652	23.00	56.83	---	---
	653	541.00	1336.81	---	---
	654	1555.00	3842.41	---	---
	655	1463.00	3615.07	---	---
	656	173.00	427.48	---	---
	659	1159.59	2865.35	13	13
	660	1929.11	4766.83	16	14
	698	58.00	143.32	---	---
	699	1083.00	2676.09	---	---
	700	2005.00	4954.36	---	---
	701	1993.00	4924.70	---	---
	743	12.00	29.65	---	---
	744	1958.00	4838.22	---	---
	745	1993.00	4924.70	---	---
	746	104.00	256.98	---	---
	788	127.00	313.82	---	---
	789	541.00	1336.81	---	---
	792	207.00	511.50	---	---
	836	127.00	313.82	---	---
NR 6-4	441	2304.00	5693.18	---	---
	485	2304.00	5693.18	---	---
	486	2304.00	5693.18	---	---
	487	2304.00	5693.18	---	---
	529	2304.00	5693.18	---	---
	530	2304.00	5693.18	---	---
	531	2304.00	5693.18	---	---
	532	2304.00	5693.18	---	---
	533	2304.00	5693.18	---	---
	534	2304.00	5693.18	---	---
	535	2304.00	5693.18	---	---
	573	2304.00	5693.18	---	---
	574	2304.00	5693.18	---	---
	575	2304.00	5693.18	---	---
	576	2304.00	5693.18	---	---
	577	2304.00	5693.18	---	---
	578	2304.00	5693.18	---	---
	579	2304.00	5693.18	---	---
	580	2304.00	5693.18	---	---
	581	2304.00	5693.18	---	---
	617	2201.00	5438.67	20	14

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (METERS)	DISTANCE FROM SHORE (STATUTE MILES)
NR 6-4	618	2304.00	5693.18	20	13
	619	2304.00	5693.18	---	---
	620	2304.00	5693.18	---	---
	621	2304.00	5693.18	---	---
	622	2304.00	5693.18	---	---
	623	2304.00	5693.18	---	---
	624	2304.00	5693.18	---	---
	625	2304.00	5693.18	---	---
	626	2304.00	5693.18	---	---
	627	2304.00	5693.18	---	---
	661	149.46	369.32	12	11
	662	1417.84	3503.48	13	10
	663	2304.00	5693.18	15	10
	664	2304.00	5693.18	20	10
	665	2304.00	5693.18	---	---
	666	2304.00	5693.18	---	---
	667	2304.00	5693.18	---	---
	668	2304.00	5693.18	---	---
	669	2304.00	5693.18	---	---
	670	2304.00	5693.18	---	---
	671	2304.00	5693.18	---	---
	706	78.48	193.92	8	7
	707	1101.76	2722.45	12	7
	708	1188.59	2937.01	15	7
	709	1324.93	3273.90	18	7
	710	1742.70	4306.21	20	7
	711	2303.79	5692.67	20	8
	712	2304.00	5693.18	---	---
	713	2304.00	5693.18	---	---
	714	2304.00	5693.18	---	---
	715	2304.00	5693.18	---	---
	755	409.05	1010.76	14	5
	756	625.10	1544.62	16	5
	757	1613.00	3985.72	---	---
	758	2281.00	5636.35	---	---
	759	2304.00	5693.18	---	---
	793	6.00	14.83	---	---
	802	438.00	1082.30	---	---
	803	1866.00	4610.89	---	---
	847	138.00	341.00	---	---

TOTAL: 616 BLOCKS 1,241,887.62 HECTARES
3,068,702.44 ACRES

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APPENDIX B

LEGAL MANDATES AND AUTHORITY

MAP INDEX	BLOCK	HECTARES	ACRES	WATER DEPTH (FATHOMS)	DISTANCE FROM SHORE (STATUTE MILES)
NK 6-4	618	2304.00	5693.18	28	13
	619	2304.00	5693.18	---	---
	620	2304.00	5693.18	---	---
	621	2304.00	5693.18	---	---
	622	2304.00	5693.18	---	---
	623	2304.00	5693.18	---	---
	624	2304.00	5693.18	---	---
	625	2304.00	5693.18	---	---
	626	2304.00	5693.18	---	---
	627	2304.00	5693.18	---	---
	661	[illegible]	[illegible]	17	14
	662	[illegible]	[illegible]	[illegible]	10
	663	2304.00	5693.18	[illegible]	[illegible]
	664	2304.00	5693.18	18	[illegible]
	665	2304.00	5693.18	---	---
	666	2304.00	5693.18	---	---
	667	2304.00	5693.18	---	---
	668	2304.00	5693.18	---	---
	669	2304.00	5693.18	---	---
	670	2304.00	5693.18	---	---
	671	2304.00	5693.18	---	---
	706	[illegible]	[illegible]	8	[illegible]
	707	[illegible]	[illegible]	[illegible]	[illegible]
	708	[illegible]	[illegible]	[illegible]	[illegible]
	709	[illegible]	[illegible]	[illegible]	[illegible]
	710	[illegible]	[illegible]	20	[illegible]
	711	[illegible]	[illegible]	[illegible]	[illegible]
	712	2304.00	5693.18	---	---
	713	2304.00	5693.18	---	---
	714	2304.00	5693.18	---	---
	715	2304.00	5693.18	---	---
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---
	[illegible]	[illegible]	[illegible]	---	---

TOTALS [illegible] BLOCKS [illegible] HECTARES
[illegible] ACRES

Legal Mandates and Authority

OCS Lands Act: The Outer Continental Shelf Lands Act of 1953 (43 U.S.C. 1331 et seq.) as amended (P. L. 95-372; 92 Stat. 629), established Federal jurisdiction over submerged lands on the OCS seaward of State boundaries (generally 3 geographic miles seaward of the coastline). Under the OCS Lands Act, the Secretary of the Interior is responsible for the administration of mineral exploration and development on the OCS. The statute empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the act.

From a national perspective, the basic purpose of the act is to expedite exploration and development of the OCS in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources of oil, and maintain a favorable balance of payments in world trade. Sand and gravel resources present an important element in oil and gas development on the OCS with respect to environmental conditions in the arctic. Section 8(K) of the OCSLA gives the Secretary authority to lease any minerals other than oil, gas, and sulphur on the OCS under the terms and conditions as he may prescribe at the time of offering the area for lease. With respect to leasing minerals on the OCS the following elements must be considered: (1) the receipt of fair market value, (2) preservation and maintenance of competition, and (3) balancing an orderly mineral resource development with protection of the human, marine, and coastal environment.

The Secretary of the Interior has designated MMS as the administrative agency responsible for managing the leasing, and exploration and development activities of submerged federal lands. Regulations which govern the leasing of mineral deposits on the OCS and the granting of rights-of-way for pipelines on the OCS are contained in 43 CFR 3300, as amended (47 CFR 25967, June 16, 1982).

Summary of OCS Law: The following discussion summarizes the provisions of the act and implementing regulations which mitigate some of the possible adverse impacts resulting from this proposal.

1. The Secretary is authorized to prescribe and amend rules and regulations at any time to provide for the prevention of waste and conservation of the natural resources of the Outer Continental Shelf and the protection of the correlative rights therein. As of the effective date, such new or amended regulations can be applied to all operations conducted under any lease.

2. The Secretary is authorized to suspend or temporarily prohibit an operation or activity pursuant to a lease or permit for environmental reasons.

3. The Secretary is authorized to cancel a lease or permit for environmental reasons.
4. The Secretary is authorized to issue regulations for unitization, pooling, and drilling agreements.

5. The Secretary is authorized to issue regulations for compliance with the national ambient air quality standards pursuant to the Clean Air Act to the extent that OCS authorized activities significantly affect the air quality of any State.

6. The Secretary may administratively cancel a nonproducing lease for the owner's failure to comply with any of the provisions of the act, the lease, or regulations under the act.

7. The Secretary may initiate a judicial proceeding to cancel a producing lease because of the owner's failure to comply with any of the provisions of the act, the lease, or regulations under the act.

8. Rights-of-way may be granted under such regulations and upon such conditions as may be prescribed by the Secretary, assuring maximum environmental protection by utilization of the best available and safest technologies.

9. Exploration must be undertaken pursuant to an approved exploration plan. No permit for dredging may be issued until all affected states with approved coastal zone management programs have concurred or have presumed to concur with the consistency determination provided by the lessee.

10. Geological explorations on unleased areas of the OCS shall be allowed only if such exploration will not be unduly harmful to aquatic life in the area, result in pollution, create hazardous or unsafe conditions, unreasonably interfere with other uses of the area, or disturb any site, structure, or object of historical or archeological significance.

11. Governors of affected states may submit recommendations to the Secretary regarding the size, timing, or location of a proposed lease sale, or with respect to a proposed development and production plan.

12. The Secretary is authorized to enter into cooperative agreements with affected states for several purposes, including but not limited to, sharing of information, joint utilization of available expertise, the facilitating of permit procedures, joint planning and review, and the formation of joint surveillance and monitoring arrangements relevant to OCS operations, both onshore and offshore.

13. The Secretary shall conduct a study of any area or region included in any mineral lease sale in order to establish information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and the coastal areas which may be affected by mineral resource development in such area or region.

14. Subsequent to the leasing and developing of any area or region, the Secretary may conduct additional studies to establish environmental information and may monitor the human, marine, and coastal environments of such area or region.

15. The Secretary shall consider relevant environmental information in making decisions, in developing appropriate regulations and lease conditions, and in issuing operating orders.

16. In exercising their respective responsibilities, the Secretary and the Coast Guard shall require, on all mining production operations and, wherever practicable, on existing operations, the use of the best available and safest technologies which the Secretary determines to be economically feasible, wherever failure of equipment would have a significant effect on safety, health, or the environment except where the Secretary determines that the incremental benefits are clearly insufficient to justify the incremental costs of utilizing such technologies.

17. The holder of a lease or permit shall maintain all operations within such lease area or within the area covered by such permit in compliance with regulations intended to protect persons, property, and the environment on the OCS.

18. The Secretary of the Interior, the Secretary of the Department in which the Coast Guard is operating, and the Secretary of the Army shall enforce safety and environmental regulations promulgated under the act. The Secretary and the Coast Guard shall promulgate regulations for onsite inspections of OCS facilities.

19. Any person having a valid legal interest which is or may be adversely affected may commence a civil action to compel compliance with the OCS Lands Act against any person, including the United States, for any alleged violation of any provision of the OCS Lands Act, or regulation promulgated thereunder, or terms of any permit or lease issued under the OCS Lands Act.

20. The Attorney General or a U.S. Attorney may institute a civil action for a temporary restraining order, injunction, or other appropriate remedy to enforce any provision of the OCS Lands Act, regulation or order issued under the act or any term of a lease, license, or permit issued under the act. Penalties available include:

a. A civil penalty of not more than $10,000 for each day of noncompliance.

b. A fine of not more than $100,000 or imprisonment for not more than 10 years, for any person who knowingly and willfully 1) violates any provision of the act, any term of a lease, license, or permit issued pursuant to the act, or any regulation or order issued under the authority of the act designed to protect health, safety, or the environment or conserve natural resources, 2) makes any false statement, representation, or certification in any application, record, report, or other document filed or required to be maintained under this act, 3) falsifies, tampers with, or renders inaccurate any monitoring device or method of record required to be maintained under this act, or 4) reveals any data or information required to be kept confidential by this act.

21. Prior to development and production of a mineral lease, the lessee shall submit a development and production plan to the Secretary for approval. The Secretary will determine whether or not the plan is a major federal action requiring the preparation of an environmental impact statement. At least once, the Secretary shall declare the approval of a development and production plan in any area or region of the OCS, other than the Gulf of Mexico, to be a major federal action.

22. The Secretary shall disapprove a development and production plan if:

a. the lessee fails to demonstrate he can comply with requirements of the OCS Lands Act or other applicable federal law;

b. activities described do not receive a consistency concurrence by a state with an approved CZM plan and the Secretary of Commerce does not make the findings authorized by 307(c)(3)(B)(iii) of the Coastal Zone Management Act;

c. operations threaten national security or defense; or

d. because of exceptional geologic conditions, exceptional value in the marine or coastal environment, or other exceptional conditions exist, that 1) implementation of the plan would probably cause serious harm or damage to life, to property, to any mineral deposits, or to the marine, coastal, or human environments; 2) the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable period of time; and 3) the advantages of disapproving a plan outweigh the advantages of development and production.

23. The Secretary shall not grant a license or permit for any activity in such a plan affecting any land or water use in the coastal zone of a state with an approved Coastal Zone Management plan, unless the state concurs or is presumed to concur with the consistency certification accompanying such plan.

24. The Secretary shall provide affected states with information to assist them in planning for the onshore impacts of possible mineral development and production.

__Federal/State Coordination:__ The OCS Lands Act, as amended, provides a statutory foundation for the Department's policy of coordination of OCS activities with affected states and, to a more limited extent, local governments. At each step of the procedures that lead to lease issuance, participation from affected states and other interested parties is encouraged and sought. Set out below is a detailed discussion of coordination mechanisms required by the OCS Lands Act.

The Secretary of the Interior is required to invite and consider suggestions from the governors of any affected state during preparation of any proposed oil and gas leasing program. Each such governor also receives a copy of the proposed leasing program for review and comment prior to its publication in the __Federal Register__. The Secretary is required to provide a written response to any request from a governor for modification of a proposed leasing program. State and local governments may comment directly on a proposed leasing program in its published form. The Secretary is obligated to establish procedures for review of proposed leasing plans and periodic consultation with state and local governments (section 18).

Within 60 days after notice of a proposed lease sale or receipt of a development and production plan, the governor of any affected state may make recommendations to the Secretary with regard to the size, timing, or location of the proposed lease sale or development and production plan. If the Secretary determines that any such recommendations provide for a reasonable balance between the well-being of the citizens of the affected state and the national interest, he must accept them. The Secretary must also respond to the governor in writing, giving his reasons for accepting, rejecting, or modifying the governor's recommendations. The Secretary may enter into cooperative agreements with affected states, for purposes consistent with the act and other applicable federal law (section 19).

When soliciting nominations for the leasing of lands within 3 miles of the seaward boundary of any coastal state, additional information is to be provided to the governor of those states. The governor must be informed of the identity of and schedule for the area proposed for leasing; the geographical, geological, and ecological characteristics of the area within 3 miles of the seaward boundary; an estimate of mineral deposits in these areas; and any field, or geologic structure in these areas. After the close of the call period, the governor is informed of any area which merits further consideration for leasing (section 8(g)); he is afforded the opportunity to enter into an agreement concerning the disposition of revenues which may be generated by a federal lease in such area.

statement. At least [illegible], the Secretary sh[illegible]
development and production plan in any area or region of the OCS, other [illegible]

(iii) of the Coastal Zone Man[illegible]

outweigh the advantages of development [illegible]

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APPENDIX C

FEDERAL REGULATORY RESPONSIBILITIES

Federal Regulatory Responsibilities

Department of the Interior: MMS is the departmental agency with direct OCS regulatory and enforcement authority. MMS implements the OCS leasing regulations under 43 CFR Part 3300, as amended, and cooperates with other federal agencies to develop special stipulations that apply to either specific leases or all leases within the proposed lease area. These stipulations address such matters as cultural and biological resources, pipeline rights-of-way, and equipment identification. In addition to issuing leases, MMS issues rights-of-way for common carrier pipelines on the OCS. MMS also issues permits and designates an authorized officer to manage each permit relative to protection of coral in the vicinity of proposed OCS operations.

MMS also is charged with developing and administering oil and gas operations on the OCS. These regulations are the basis for OCS operating orders which apply to specific operations on the proposed lease area. Regulations and corresponding operating orders for sand and gravel operations and development are in the process of being developed.

Although MMS is the departmental agency with direct OCS regulating and enforcement authority, other federal agencies are also involved in the regulatory process of OCS mineral operations. The following is a summary of these statutory and operational requirements:

A. The U.S. Fish and Wildlife Service (FWS): FWS shares responsibilities with other agencies for protection of fish and wildlife resources and their habitats and acts in an advisory capacity in the formulation of OCS leasing stipulations. FWS is provided an opportunity to comment on proposed exploration plans and environmental reports submitted to MMS by lessees prior to approval of any such plan of operations. It also provides recommendations to the Corps of Engineers in the issuance of Federal permits to industry for construction in navigable waters. FWS is also responsible for the protection and stewardship of certain species covered under the Endangered Species Act of 1973 and the Marine Mammal Protection Act of 1972.

B. U.S. Army Corps of Engineers: The OCS Lands Act provides authority to the Secretary of the Army to prevent obstruction to navigation in U.S. navigable waters, and to prevent obstructions caused by structures located on the OCS. Section 10 of the Rivers and Harbors Act of 1899 (30 Stat. 1151) requires that permits be issued for all offshore construction, including pipelines, in U.S. navigable waters.

The Corps of Engineers has permitting responsibility for any structure or any other work done in, or affecting, U.S. navigable waters, as well as construction of artificial islands, fixed structures, and other installations on the OCS.

Permits must also be issued for onshore facilities in which dredging and filling of U.S. navigable waters are involved. Structure permits for exploration drilling vessels and for fixed and mobile platforms are issued by the Corps. Environmental requirements must be considered prior to issuance of permits for structures in state waters pursuant to Section 404 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977. Section 404 also delegates regulatory authority to the Secretary of the Army for discharge of dredged or fill material in wetlands, as does Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 as amended.

C. Department of Transportation (DOT): The OCS Lands Act grants authority to the Coast Guard to promulgate and enforce regulations covering lighting and warning devices, safety equipment, and other safety-related matters pertaining to life and property on fixed OCS platforms and drilling vessels. Through the Coast Guard, the DOT advises the Corps of Engineers on the issuance of permits and the placement of offshore structures. Under the Port and Waterways Safety Act (33 U.S.C 1221), as amended by the Port and Tanker Safety Act of 1978, the Coast Guard has the authority to establish shipping safety fairways and port access routing in U.S. coastal waters, and to establish standards for vessels in domestic trade which transport hazardous cargos. The Coast Guard also has jurisdiction to enforce the Clean Water Act of 1977 on the OCS.

D. Department of Commerce: The Department of Commerce, through the National Oceanic and Atmospheric Administration (NOAA), is responsible for protection of marine fisheries resources and their habitats, the designation and management of marine sanctuaries, and for providing recommendations to the Corps of Engineers as the entity which issues permits in navigable waters.

Some of the Department's responsibilities and authorities related to OCS development include the Fishery Conservation and Management Act of 1976, the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, the Fur Seal Act of 1966, Title II of the Marine Protection, Research, and Sanctuaries Act of 1972 ("Comprehensive Research on Ocean Dumping"), and the National Ocean Pollution Research and Development and Monitoring Act of 1978.

The Department of Commerce is responsible for administration and implementation of the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451-1464) including administration of federal grants to states, loan programs for states affected by OCS impacts within the coastal zone, and implementation of the Federal consistency provisions of the CZMA. NOAA regulations implementing the Federal consistency provisions of the Coastal Zone Management Act, as amended, with approved coastal management programs are contained in 15 CFR 930, revised as of January 1, 1980.

Under the Marine Protection, Research, and Sanctuary Act of 1972 (16 U.S.C. 1431-1434), the Secretary of Commerce is empowered, if the President approves, to designate areas as marine sanctuaries "as necessary for the purpose of preserving or restoring such areas for their conservation, recreation, ecological, or esthetic values," following consultation with the Secretaries of State, Defense, Interior, and Transportation, the Administrator of EPA, and other interested agencies. Once an area is designated a marine sanctuary, NOAA's Office of Coastal Zone Management is required to issue "necessary and reasonable regulations" for control of activities permitted within the marine sanctuary. Multiple uses (including mineral development) could be permitted within a marine sanctuary, providing these uses are consistent with the regulations governing the sanctuary. These regulations regarding designation and management of marine sanctuaries are contained in 15 CFR 922, revised as of January 1, 1980.

F. Environmental Protection Agency (EPA): The Federal Clean Water Act, as amended (33 U.S.C. 1251 et seq.), provides several authorities applicable to wastewater discharges from OCS operations. These authorities are administered by the EPA and include the following:

Section 403(c) of the Act requires EPA to promulgate ocean discharge criteria which consider the effects of pollutants disposed against multiple ocean use objectives. These criteria, published October 3, 1980, and effective November 3, 1980, are used as guidelines in EPA's issuance of National Pollutant Discharge Elimination System (NPDES) permits.

Section 301(b)(1)(a) of the Act requires EPA to issue effluent limitations for existing point sources of wastewater discharge which reflect the application of "best practicable control technology currently available" (BPTCA or BPT; 33 U.S.C. 1311(b)(1)(a)). The BPTCA standards would apply to existing OCS exploratory drillships, semi-submersible vessels, jack-up rigs, etc., used in exploration operations.

Section 301(b)(2)(a) requires EPA to promulgate effluent limitations for categories and classes of point sources which shall require application of "best available control technology economically achievable" (BAT). The limitations regarding toxic pollutants identified in the act would apply to both exploration and production operations on the OCS.

Section 306(b)(1)(b) of the Act requires the EPA to promulgate federal standards of performance in pollution control from new sources for categories and classes of industries designated either in the act or at the Administrator's discretion.

Section 307(a)(1) of the Act requires the EPA to promulgate a list of toxic pollutants for purposes of pollution control. Section 307(a)(2) requires the EPA to promulgate effluent limitations for each of the identified toxic pollutants.

Section 402(a)(1) of the Act confers permitting authority upon the EPA to meet the regulatory responsibilities of several sections of the act, e.g., sections 301, 306, and 307 mentioned above. The National Pollution Discharge Elimination System (NPDES) falls under this section of the act; it applies to all sources of wastewater discharges from exploratory vessels and production platforms operating on the OCS.

Dilution ratios, discharge rates, discharge locations, and seasonal restrictions are established on a case-by-case (permit-by-permit) basis. EPA does also impose a standard of no free oil discharge from the facility from any point source and no discharge of oil-based or oil-contaminated drilling muds. EPA also includes Alaska State Water Quality Standards in NPDES permits if appropriate. These include total hydrocarbon limitations of 15 ug/l and total aromatic hydrocarbon limitations of 10 ug/l at the edge of the mining zone.

EPA also has some responsibility for facilities not related to transportation, such as terminal and storage facilities, and permits for any discharges would be issued by EPA or designated states according to established effluent guidelines. Some provisions of the Clean Water Act also apply to onshore facilities and OCS-related activities.

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